DOCUMENT RESUME

ED 439 002 RC 022 331

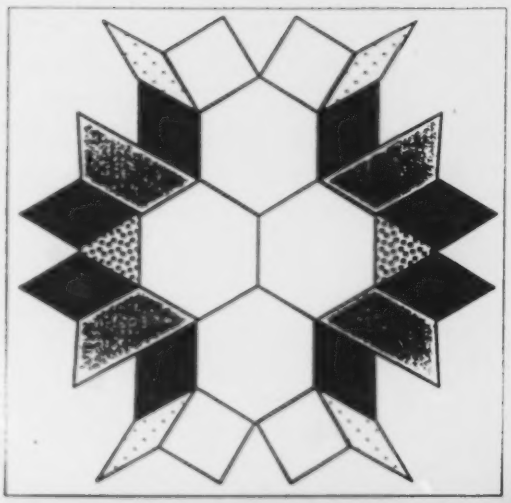
AUTHOR	Carter, Carolyn S.; Cohen, Sara; Keyes, Marian; Kusimo, Patricia S.; Lunsford, Crystal
TITLE	UnCommon Knowledge: Projects That Help Middle-School-Age Youth Discover the Science and Mathematics in Everyday Life. Volume Two: Hands-On Math Projects.
INSTITUTION	EkIC Clearinghouse on Rural Education and Small Schools, Charleston, WV.; AEL, Inc., Charleston, WV.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.; National Science Foundation, Arlington, VA.
PUB DATE	2000-00-00
NOTE	129p.; For "Volume 1: Hands-On Science Projects," see RC 022 273.
CONTRACT	ED-99-CO-0027; HRD-9815117
AVAILABLE FROM	Full text at Web site: http://www.ael.org/eric/voices/math.htm.
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Design Crafts; *Geometry; *Handicrafts; Mathematical Enrichment; *Mathematics Activities; Mathematics Instruction; Middle Schools; Rural Education; School Community Relationship; Symmetry; Womens Education
IDENTIFIERS	*Hands on Mathematics; *Quilting; Tessellations

ABSTRACT

This guide contains hands-on mathematics activities to connect middle-school students to the traditional knowledge of their grandparents and elders. Because girls often lose interest in math at the middle-school level, and because women in some communities (especially in rural areas) are seldom involved in work with an obvious math basis, the activities explore common practices associated with women for generations. The guide has two sections. "Pieces of Mine: The Mathematics of Quilting" leads students into the worlds of plane geometry, symmetry, and tessellations. Through quilting, students take a hands-on approach to mathematics, spatial sense, culture, and history. Activities include a symmetry hunt, 2-D geometry with pattern blocks, and designing quilt patterns. "Crafty Mathematician: Making Art through Mathematics" provides mathematical skill-building activities while helping learners understand the math embodied in many craft activities. Students explore Cartesian coordinates, 2-D and 3-D geometry, measurement, symmetry, and volume. Activities include making ornaments, pictures, boxes, and a kaleidoscope. Each section includes an introduction, cautions, community connections, benefits to learners and communities, ideas for additional projects, readings, leader background information, activity descriptions, and handouts. (SV)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 439 002



UnCommon Knowledge: Projects That Help Middle-School-Age Youth Discover the Science and Mathematics in Everyday Life

Volume Two: Hands-On Math Projects

by Carolyn S. Carter
with Sara Cohen, Marian Keyes, Patricia S. Kusimo, Crystal Lunsford

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

RC 022331

UnCommon Knowledge:
Projects That Help Middle-School-Age Youth Discover the Science and Mathematics in Everyday Life

Volume Two:
Hands-On Math Projects

by

Carolyn S. Carter

with

Sara Cohen, Marian Keyes, Patricia S. Kusimo, Crystal Lunsford

Charleston, West Virginia

ERIC

Clearinghouse on Rural Education and Small Schools

AEL, Inc.

P.O. Box 1348, Charleston, WV 25325-1348

http://www.ael.org

Copyright © 2000 by AEL, Inc.

All rights reserved except for use by the U.S. Government.

Illustrated by Dawn Pauley

Some illustrations in Guide 4 created by Sara Cohen

Layout design by Carolyn Luzader, Dawn Pauley, and Michael Switzer

This publication was prepared with funding from the National Science Foundation under grant no. HRD-9815117 and with funding from the U.S. Department of Education, Office of Educational Research and Improvement, National Library of Education, under contract ED - 99-CO-0027. Other funding was provided by Union Carbide Corporation, Lyondell Chemical Corporation, and AEL, Inc.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, the U.S. Department of Education, AEL, Union Carbide, or Lyondell.

The ERIC Clearinghouse on Rural Education and Small Schools is operated by AEL, Inc. AEL is an Equal Opportunity/Affirmative Action Employer.

Contents

Preface viii

Pieces of Mine: The Mathematics of Quilting

Introduction 4-1
- Cautions 4-3
- Community Connections 4-3
- Activities: Brief Descriptions 4-3

Why Study Quilting?
- Benefits to Learners 4-4
- Benefits to the Community 4-5
- Ideas for Additional Projects 4-5
- Readings for Young People 4-5

Leader Background Information 4-6

Activities
- Activity 1: Quilts as Art and Life: Stories Told by Quilts and Quilters 4-7
- Activity 2: What Do I See? An Introduction to Tessellations and Symmetry 4-10
- Activity 3: Tessellating Shapes 4-12
- Activity 4: Kaleidoscope on a Desk! Creating Symmetric Designs 4-14
- Activity 5: Symmetry and Tessellation Scavenger Hunt 4-15
- Activity 6: The Way I See It 4-16
- Activity 7: Creating a Piece of Myself 4-18
- Activity 8: Our Own Stories 4-20
- Materials Summary 4-21

Activities Handouts
- Handout 1-1: Quilts as Art and Life 4-23
- Handout 1-2: My Mathematics Dictionary 4-24
- Handout 1-3: Horses, Hearts, and Hexagons 4-32
- Handout 1-4: "Quilting Bee" Directions 4-33
- Handout 1-5: Quilt Block Designs 4-34
- Handout 2-1: How many lines of symmetry can you find? 4-38
- Handout 2-2: Symmetry in Block Designs 4-40
- Handout 2-3: Slides, Turns, and Flips 4-43
- Handout 2-4: What Do I See? 4-46
- Handout 3-1: Pieces of Mine 4-47
- Handout 3-2: Nibbles and Slides 4-52
- Handout 4-1: Creating Symmetric Designs 4-56

Handout 5-1: Scavenger Hunt: Symmetry and Tessellations 4-57
Handout 6-1: Sample Pattern Block Patterns 4-64
Handout 6-2: Pattern Blocks 4-66
Handout 7-1: More Pattern Blocks 4-67
Handout 7-2: Reverse Letters 4-68
Handout 7-3: A Quilting Poem 4-70
Handout 8-1: Some Resources on Quilting 4-71

Notes 4-72

The Crafty Mathematician: Making Art Through Mathematics

Introduction 5-1
Cautions 5-1
Community Connections 5-1
Activities: Brief Descriptions 5-2

Why Study Mathematics through Crafts?
Benefits to Learners 5-2
Benefits to the Community 5-3
Ideas for Additional Projects 5-4
Readings for Young People 5-4

Leader Background Information 5-4

Activities
Activity 1: It's All a Plot! 5-5
Activity 2: The Plot Deepens--Coordinate Ornaments 5-7
Activity 3: 3-D Geometry--Space Out! 5-9
Activity 4: Reflections of My World--Building a Kaleidoscope 5-11
Activity 5: When You Wish Upon a Star--Geometric Line Ornaments 5-13
Activity 6: Something's Squirrely Here--Ribbon Pinecones? 5-15
Activity 7: Wrap It Up!--Gift Boxes from Greeting Cards 5-17
Activity 8: Making Life Beautiful--Talking with Crafters, Studying Local Crafts 5-18
Materials Summary 5-19

Resources 5-21

Activities Handouts
Handout 1-1: Picture Plots 5-23
Handout 1-2: Turkey Puzzle 5-24
Handout 1-3: Puzzle Grid 5-26
Handout 1-4: Place Your Picture Here 5-27
Handout 2-1: X,Y Coordinate Ornaments 5-29
Handout 2-2: Coordinate Ornaments 5-30
Handout 2-3: Tree Coordinates 5-31

Handout 2-4: Wreath Coordinates 5-32
Handout 2-5: Pumpkin Coordinates 5-33
Handout 3-1: 3-D Geometry 5-34
Handout 3-2: Pentagonal Prism 5-35
Handout 3-3: Tetrahedron 5-36
Handout 3-4: Pyramid 5-37
Handout 3-5: Prism 5-38
Handout 3-6: Octahedron 5-39
Handout 3-7: Icosahedron 5-40
Handout 3-8: Rhombohedron 5-41
Handout 3-9: Three-Dimensional Solids 5-42
Handout 4-1: Kaleidoscope 5-43
Handout 5-1: Geometric Line Ornaments 5-44
Handout 5-2: Pentagon Template 5-45
Handout 6-1: Ribbon Pinecones 5-46
Handout 7-1: Gift Boxes 5-47

Preface

You and the young people you work with are about to have an adventure. You will discover treasures growing in a local woods or vacant lot and other treasures living in the skills and memories of grandparents and elders. In a world that seems to value only the most current information and the newest findings in science, it is easy to overlook the value of traditional knowledge. Yet, scientists all over the world have begun to seek out this kind of knowledge as the basis for new research in medicine, agriculture, forestry, and other areas of applied science.

We hope the activities in these guides will inspire youth to learn from and develop new respect for the wisdom of elders so they can carry on this knowledge. In fact, when you finish this adventure, you may no longer consider it remarkable that the human race survived for thousands of years before modern science and medicine.

You will find yourself speaking words you once thought belonged only to people in white coats. It is our hope that some of the youth in your group will get so involved and comfortable with the ideas and concepts in these activities that they will want to continue the adventure. These young people may find themselves signing up for more science and math classes in school—or simply pursuing their own curiosity.

We were especially mindful of girls as we developed these activities because research and experience have shown that too many girls lose interest in science and math at the middle school level. In many communities (especially in rural areas), few women are involved in work that is based on an obvious science or math background. So girls do not have pictures in their minds about possible careers in medicine, research, engineering, or other technological or scientific pursuits. We thought a good place to help girls make connections with science and mathematics might be in exploring some common practices that have been associated with women for many generations. For this reason, we have activities related to quilt designs, food preservation, nutrition, and home health remedies. From this starting point, girls will uncover other uses for science and math.

Although we focused on girls' needs for relevance in studying science, we do not mean to exclude boys. Many boys have enjoyed doing these projects, too. The guides are intended to get you and your group members—girls or boys—involved up to your elbows in the sometimes messy and open-ended problems of science and mathematics in the real world. Encourage youngsters in your group to extend some of the ideas to school science or social studies projects.

We include lots of background information, definitions, and other assistance for adult leaders whose knowledge about science and math may be a little rusty. You should find all the instructions, handouts, and guidance about where to get needed materials (most can be purchased at your local grocery store).

Volume One: Hands-On Science Projects is divided into three sections:

1. *Eyes on Herbs: The Science of Folk Medicine and Natural Dyes* examines traditional uses of plants for medicines and dyes. Learners interview adults about folk remedies, investigate common herbs and plants, research connections between traditional and modern medical treatments, and experiment with natural dyes.
2. *Food for Thought: The Science of Nutrition* helps learners understand dietary recommendations; analyze their eating habits; explore connections among food, nutrition, and culture; decode food labels; and plan for healthy eating.
3. *The Science of Food Preservation: Crocked Cabbage, Jerked Beef, and Pickled Pigs' Feet* brings together microbiology, chemistry, physics, sociology, politics, and history through various food preservation activities. Learners explore pH, osmosis, air pressure, microorganisms, heat, temperature, food additives, freezing, dehydration, fermentation, and other preservation-related topics.

Volume Two has two sections focusing on mathematics:

4. *Pieces of Mine: The Mathematics of Quilting* leads learners into the worlds of planar (plane) geometry, symmetry, and tessellations. Through quilting, learners take a hands-on approach to mathematics, spatial sense, culture, and history. Activities include a symmetry hunt, 2-D geometry with pattern blocks, and designing quilt patterns.
5. *Crafty Mathematician: Making Art through Mathematics* provides mathematical skill-building activities while helping learners understand the mathematics embodied in many craft activities. Learners explore Cartesian coordinates, 2-D and 3-D geometry, measurement, symmetry, and volume; activities include making ornaments, pictures, boxes, and a kaleidoscope.

The guides are based on activities used in Rural and Urban Images: Voices of Girls in Science, Mathematics, and Technology (Voices). Voices was funded by the National Science Foundation and operated by AEL, Inc., an educational research and development organization based in Charleston, West Virginia. This three-year program engaged middle-school-aged girls in the study of science and mathematics in culturally appropriate contexts for southern Appalachia. The program included mentors, an advocacy network, a tutoring program, and monthly workshops.

A 56-minute documentary describes the program and the positive impacts it had on girls of varying abilities, most from rural, low-income circumstances. For a copy of the videotape, *UnCommon Knowledge: The Voices of Girls Documentary*, contact the ERIC Clearinghouse on Rural Education and Small Schools (800-624-9120, e-mail: ericrc@ael.org). An implementation guide will be available in late autumn 2000.

Many people contributed to these project guides. The authors would like to thank the following organizations and people for their assistance, feedback, and contributions.

Sara Cohen, with the Making Connections Program (HRD-9714751)-also funded by the National Science Foundation's Program for Women and Girls- contributed activities and feedback for the *Pieces of Mine* section.

Reviewers, field-test teachers, and workshop leaders provided important ideas and feedback for the units: Theresa Bales, James R. Calhoun, Beth Cipoletti, Ruth Davis, Sonja Davison, Kathi Elkins, Barbara Freeman, Terry Harper, Michael Kees, Wanda Kirschner, Melissa Lovejoy, Mary Martin, Katie McDilda, Julie Lee McQuerrey, Christine Michael, Janine Olian, Kim Poe, Betty Rice, Virginia Rogliano, Robert Seymour, F. Steven Underwood, and reviewers from the Black Diamond Girl Scout Council.

Special thanks to Renee Poe, Carla McClure, Stan Bumgardner, Carolyn Luzader, Dawn Pauley, and Nancy Balow at AEL for their careful preparation of this manuscript. We also wish to express our gratitude to our late friend and colleague Cecilia Thompson, whose careful and good-hearted assistance contributed greatly to the quality of these guides.

Pieces of Mine

The Mathematics of Quilting

Introduction

Many young people are familiar with quilting, but most are not aware of the mathematical knowledge it takes to create a quilt. This project helps them appreciate the knowledge and skills required to create this form of art. It also helps learners develop mathematical skills and increases their awareness of the rich history and culture of quilting. They will discover that quilting, an activity traditionally done by women in American society, has long been practiced by both men and women of many cultures. Quilting reflects people's heritage, politics, and voices.

Learners will discover that quilt blocks are composed of geometric shapes and see how they fit together to create designs. They will be introduced to *symmetry* and *tessellations*, important aspects of making quilt patterns. Learners will create their own tessellating images and symmetry and search for examples of these concepts in their world. Learners will design a quilt block pattern and choose materials that tell their own stories. They will do a presentation on quilting, culture, and history.

Quilting has been done in many cultures for many reasons. The earliest known record of a quilt dates back to 3,400 B.C.—an ivory statue of the Pharaoh of Egypt wearing a quilted royal garment.[1] In the Middle Ages, men wore quilts instead of armor for protection. Throughout this time in Europe, quilting was important in the economy and knowledge of quilting was controlled. Even though quilting is now considered by many to be women's work, at that time men controlled needle and fabric art, including quilting. Guilds were established to provide instruction to men in this field. Women and children were not allowed to participate in these guilds.

As English, Welsh, and Dutch settlers came to North America, they brought their skills and knowledge of quilting with them. By then, quilting was done mainly by women in these cultures. Women were discouraged from creating paintings, sculptures, and other public art forms, but

< Definitions

Symmetry is a mathematically useful property of an object. An object has symmetry if it looks exactly the same after it has undergone some transformation, such as rotation or reflection. For example, an object has line symmetry if you can draw a line through the object dividing it into parts that are mirror images of one another. A circle has rotational symmetry and reflection symmetry.

Tessellations are repeating geometric patterns. An example is floor tile. Definitions for these and other terms in this project can be found in Handout 1-2, "My Mathematics Dictionary."

quilting was an art they could practice in their own homes. Besides providing warmth, quilts made of leftover scraps also provided lasting memories of people, places, and times.

Quilting provided a way for women to keep their families warm by recycling materials and fabrics. During and after the Great Depression of the 1930s, quilts were sometimes made by using scraps of worn-out feed sack dresses.

Quilts serve as a medium for telling and recording history. During the time of slavery, many African American women made quilts not only for their owners but for themselves and their families. Quilts told the story of African American struggles and reflected African culture and language that slaves were not allowed to express more openly.[2] They used knowledge of dye making brought from Africa to make quilts that were often very colorful. The abolitionist movement made powerful use of quilts. Many quilts produced during this time held codes that provided directions for slaves escaping to freedom.[3] They were hung on safe houses along the Underground Railroad.[4] Numerous quilt patterns, including the Underground Railroad, Jacob's Ladder, North Star, and Slave Chain, were named after the African American struggle for freedom.

Traditionally, African quilts were made by men because men were responsible for weaving in African societies. Many of these quilts had large shapes, bright colors, and weave patterns that were quite different from European quilts. They also tended to have less symmetry than European quilts.[5]

Native American women began creating quilts in the 1880s after learning this craft from the wives of Christian missionaries or in boarding schools. Star quilts, created by Lakota women, are used in religious ceremonies or rituals and as gifts.[6] Hawaiian women learned to quilt from New England missionaries in the early 1800s. They expressed Asian influences on their culture by developing intricate quilt patterns based on ancient Japanese paper-cutting art.[7]

Before it became acceptable for women to vote or express their opinions in public, they used quilts to make political as well as personal statements. Women supported the abolitionist movement and civic causes by creating quilts that expressed their opinions. These were sold to raise money for the causes. Quilting also provided a way for women to socialize. During the 1800s and early 1900s women gathered for quilting bees. They shared quilting techniques and strengthened relationships with one another. Quilting bees were especially important in the West and the Great Plains, where homes were farther apart and women had fewer opportunities to visit one another. Women looked forward to working together on quilts for special occasions. During this era

quilts were used not only for bed covers but also for door and window covers, and as a form of currency.[8]

Quilting continues today in many cultures and in many societies. Quilts made by Amish women are famous for their unique colors, elaborate designs, and geometric shapes. The Japanese are known for their quilting patterns and intricate detail.[9] Historically, Appalachian women were taught quilting skills by their grandmothers and mothers. They continue this legacy because it brings them joy, encourages artistic expression, and connects them to the traditions of their ancestors. Quilting also serves as a source of income for many women. There are many female artists around the world who display their quilts in museums and galleries or on the World Wide Web.

Because of the long, rich history of quilting, many culturally unique and colorful patterns have been handed down from generation to generation. Many can be found in books or on the Internet. Encourage learners to research these patterns as they create their own designs that reflect their cultures and their voices. Let these designs truly be pieces of themselves, reflecting the colorful and varied patterns of individual lives.

Cautions

This project is not a primer on quilting. It does not address the processes of making pattern blocks into quilts. Some information on this process will come from the quilters who learners will interview. Otherwise, learners will need to engage in additional research if they want to make an actual quilt.

Community Connections

This project should be tied closely to community resources and events. Learners can interview quilters, explore local quilt exhibits in museums and cultural events, and look at the economic and historical role of quilts in their community. At the end of the project, learners should plan an exhibit, Web site, poster, or some other publication or event to share what they have learned with the community.

Activities: Brief Descriptions

Activity 1: Quilts as Art and Life: Stories Told by Quilts and Quilters. Learners hear quilters tell the stories of their work. This activity gets learners ready to explore the mathematics of quilting.

Activity 2: What Do I See? An Introduction to Tessellations and Symmetry. This activity introduces young people to the mathematics of quilting, with a special focus on symmetry, the motions of shapes, and tessellations.

Activity 3: Tessellating Shapes. Learners develop their own tessellated shapes.

Activity 4: Kaleidoscope on a Desk: Creating Symmetric Designs. Learners use the ancient arts of paper cutting and folding to create beautiful artwork.

Activity 5: Symmetry and Tessellation Scavenger Hunt. Learners become aware of patterns in the world around them as they search for symmetry and tessellations, both natural and human-made.

Activity 6: The Way I See It. As a prelude to designing quilt patterns, learners experiment with expressing themselves through geometry. They design patterns with pattern blocks and sponge-paint their own tessellating design.

Activity 7: Creating a Piece of Myself. Learners create their own quilt pattern. They may put the pattern on a T-shirt or book bag.

Activity 8: Our Own Stories. Learners are encouraged to do further research or develop a product or presentation and share it with the community.

Why Study Quilting?

Benefits to Learners

Quilting is a form of art that has lasted through many centuries and many cultures. It embodies the history of families and societies. The art of quilting requires not only mathematical knowledge and skill; it also combines these skills with many disciplines, including art, history, and science. Quilts have practical, symbolic, social, and political meanings. They reflect many issues of historical and cultural significance.

Topics and Concepts. Various activities give learners the opportunity to develop their knowledge of history and mathematics:

- quilting processes and patterns
- geometric shapes and their names
- symmetry
- tessellations
- geometric shapes and their motions
- quilting as a way of relating history and culture

Skills. This project helps learners develop skills they can use throughout life:

- spatial sense
- pattern recognition and development
- research skills (data collection, interviewing, presentation, Internet and library use, organizational skills)
- fine motor skills

Career links. Learners make connections with a variety of careers, including those of a quilter, mathematician, graphic designer,

architect, artist, anthropologist, and historian. They also explore the science and history of textiles.

Compliance with national standards. This project addresses the National Council of Teachers of Mathematics Standards for grades 5-8:

- Pattern and Functions
- Geometry and Spatial Sense
- Mathematical Connections

Benefits to the Community

Through an increased recognition of local heritage and cultures, this project can build connections between young people and adults. Young people will come to honor the quilters in their community as people who have and use significant mathematical knowledge. Through their presentations, learners may spark community appreciation for a traditional craft. They may even serve as motivators for a homegrown industry!

Ideas for Additional Projects

The activities in this project emphasize mathematics, but quilts can be used to explore other topics as well—language arts, social studies, history, art, and sociology. Learners can research quilting's history, cultural aspects, and mathematical concepts. They can create a quilt (or wall hanging) and display it in their classroom or meeting place. They could even raffle it off to raise money for a cause. Some might want to research and contribute to the National AIDS quilt or take a trip to a quilt contest or display. Others might design their own tilings or study Escher's work and develop their own "impossible" Escher-type designs. They could put together a picture book on local symmetries in nature. They could develop tessellations based on culturally relevant designs and use these to decorate items they sell at a crafts fair. If you live in an area where quilting is popular, you might have learners investigate the role of quilts in the local economy. The activities and readings suggested here can spark young people's interest in a variety of topics.

Readings for Young People

The Log Cabin by Ellen Howard (Ronald Himler, illustrator). Ages 4-8. New York: Holiday House, 1996.

The Quilt by Ann Jonas. Ages 4-8. New York: Puffin Books, 1994.

Sam Johnson and the Blue Ribbon Quilt by Lisa Campbell Ernst. Ages 4-8. New York: Lothrop, Lee & Shepard Books, 1983.

Eight Hands Round: A Patchwork Alphabet by Ann Whitford Paul (Jeanette Winter, illustrator). Ages 4-8. New York: HarperTrophy, 1991.

The Josefina Story Quilt (I Can Read) by Eleanor Coerr (Bruce Degen, illustrator). Ages 4-8. New York: HarperTrophy, 1989.

Hidden in Plain View: The Secret Story of Quilts and the Underground Railroad by Jacqueline Tobin and Raymond Dobard. Ages: young adult. New York: Doubleday, 1999.

With Needle and Thread: A Book About Quilts by Raymond Bial. Ages 4-8. Boston: Houghton Mifflin, 1996.

Sweet Clara and the Freedom Quilt by Deborah Hopkinson. Ages 4-8. New York: Knopf, 1993.

Follow the Drinking Gourd by Jeanette Winters. Ages 4-8. New York: Knopf, 1988.

Nell's Quilts by Susan Terris. Ages 9-12. Chicago: Sunburst Press, 1996.

The Canada Geese Quilt by Natalie Kinsey-Warnock (Leslie W. Bowman, illustrator). Ages 9-12. New York: Cobblehill Books/Dutton, 1992.

The Boy and the Quilt by Shirley Kurtz (Cheryl Benner, illustrator). Ages 4-8. Intercourse, PA: Good Books, 1991.

Bess's Log Cabin Quilt by Anne D. Love (Ronald Himler, illustrator). Ages 9-12. New York: Holiday House, 1991.

Quilting Now & Then by Julie B. Dock and Karen B. Willing (Sarah Morse, illustrator). Ashland, OR: Now & Then, 1994.

Leader Background Information

Background information for project leaders, as needed, is included in each activity.

Handout 1-2 is a mathematical dictionary that learners will use throughout this project.

Activity 1

Quilts as Art and Life: Stories Told by Quilts and Quilters

Leader Notes

I've been a hard worker all my life, but 'most all my work has been the kind that "perishes with the usin'," as the Bible says. That's the discouragin' thing about a woman's work. If a woman was to see all the dishes that she had to wash before she died piled up before her in one pile, she'd lie down and die right then and there. I've always had the name o' bein' a good housekeeper, but when I'm dead and gone there ain't anybody goin' to think o' the floors I've swept, and the tables I've scrubbed, and the old clothes I've patched, and the stockin's I've darned, but when one of my grandchildren or great-grandchildren sees one o' these quilts, they'll think about Aunt Jane, and, wherever I am then, I'll know I ain't forgotten.

—Eliza Calvert Hall, *Aunt Jane of Kentucky*

This activity introduces learners to the personal dimensions of quilting. As they hear the voices of those who quilt and observe and study quilts, they learn of the cultural importance of this art form. As they write and publish the stories quilters tell about their art, learners also develop writing, note-taking, and storytelling skills while preserving traditional knowledge. They will see that quilting involves much more than having the ability to sew. Quilters must have a strong sense of geometry to piece together shapes that create pleasing new patterns. Design and color choices make each quilt unique and appealing to the eye. Through the process of telling the stories of quilters, learners honor this knowledge.

Key Questions

- How do quilters use geometric shapes and patterns to tell stories and express their culture and history?
- What are some geometric shapes important to quilting?

Materials Checklist

- ☐ Quilter(s) who have agreed to be interviewed
- ☐ Handout 1-1 (1 per learner)
- ☐ Handout 1-2 (1 per learner)
- ☐ Handout 1-3 (optional, 1 per learner)
- ☐ Handout 1-4 (optional, 1 per learner)
- ☐ Handout 1-5 and safety pins or tape (optional)
- ☐ Quilts (learners are invited to bring these from home)
- ☐ Cameras with flashes and film (at least 1 per group)
- ☐ Pencils (1 per learner)

Approximate Time Required

Presentations by and interviews with quilters, time varies

Developing, testing, and revising question list, 45-90 minutes

Developing form for taking notes, 20 minutes

Making scrapbook, Web page, etc., time varies—depending on format

Horses, Hearts, and Hexagons puzzle (optional), 15 minutes

Quilting Bee (optional), 20 minutes

Environmental Notes

Save photos and stories for posters, presentations, scrapbook, Web sites.

Save copies of Handout 1-5 to use in Activity 2.

Recycle any leftover paper.

- What role does quilting play in the lives of people who quilt?

Invite someone who quilts to come and speak to learners. Ask this person to bring a quilt or some quilt blocks to exhibit. Quilters can tell about why they began to quilt, how they learned, the purposes for quilting, and their own experiences with quilting. Have learners take pictures of the quilter and the quilts or pattern blocks that the quilter brings.

To prepare for the interview, learners should develop a list of questions they want to ask the quilter(s). Handout 1-1 provides some topics for learners to think about when developing their interview questions.

Based on their list of questions, learners should develop a form for taking notes. They will use these notes to write articles or stories about the quilter.

Allow learners to practice interviewing one another before they interview the quilter(s). If possible, have them bring quilts from home and share the backgrounds of their own quilts. Remind them that the interview process should not be a rigid question-and-answer session. Rather, information will emerge naturally as people relate their stories. The questions that learners develop can help them prepare to be good listeners. Questions should be asked whenever additional information is needed, or if the interview gets bogged down. The stories that learners write after they interview the quilter(s) can be submitted to school or local newspapers, developed into photo essays, or published on the World Wide Web. They could also be used as part of a group or classroom scrapbook.

Handout 1-2 is a mathematical dictionary that learners can use throughout this project. It will serve as a handy introduction to geometric figures.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handouts 1-1 and 1-2.
- ☐ If you are using Handouts 1-3 or 1-4 and 1-5 at this time, copy these handouts.
- ☐ Work with learners to arrange presentations by and interviews with quilters.
- ☐ Work with learners to decide what form their displays will take (posters, WWW sites, etc.).

Note

You will also use the photos taken during this activity as part of Activity 2.

Optional Exercise #1: Horses, Hearts, and Hexagons (Puzzle)

Handout 1-3 is a puzzle that can be used now—or later during the project, if you prefer. The puzzle *Horses, Hearts, and Hexagons* is based on the Nine Patch, a common quilt design. A Nine Patch design is made by dividing a large square into nine smaller squares—three rows of three smaller squares in each row. There are many Nine Patch patterns. Some of the simplest Nine Patch patterns are made by varying light and dark colors in symmetric patterns.

Some star designs that came to America from England are based on the Nine Patch.

Give each learner a copy of Handout 1-3. Tell learners to cut the puzzle into nine pieces, shuffle them, then move the pieces around to re-create the design. This allows them to practice the motions of slides and turns described in Handout 1-2. Ask learners what strategies they used to solve the puzzle. Their strategies may vary. Some might say they just made a "lucky guess." Others might have used symmetry or made an organized plan of testing pieces and eliminating those that didn't match up.

Here are some other questions you might want to ask:

- All the pieces have horses on them. How did you decide if two pieces did or didn't fit next to each other?
- Were there any pieces you could tell right away that went together? How so?
- Were there any pieces that you decided had to go on the outside? How?
- Would it have helped if you knew which piece went in the middle?
- What motions did you use when solving your puzzle?
- Were any of the horses mirror (flipped) images of each other?
- Did the symmetry of the hexagons and hearts make it easier or harder to solve the puzzle?
- Which did you find were easier to match up—the horses, hearts, or hexagons?
- How many lines of symmetry do the horses, hearts, and hexagons have? (The horses do not have any reflectional, or line, symmetry. The hearts have one line of symmetry. The hexagons have six lines of symmetry.)

Optional Exercise #2: Quilting Bee

Handouts 1-4 and 1-5 are parts of an activity called the *Quilting Bee*. The Quilting Bee is an excellent icebreaker if learners in your group do not know one another, or you could use the activity as an introduction to this project. In the Quilting Bee, learners tape or pin paper quilt squares to one another's backs. No one is allowed to see which pattern is being taped on them. Learners must try to determine the name of the pattern that they have by asking one another yes-or-no questions.

Complete directions for the activity are found on Handout 1-4. The quilt patterns are printed on Handout 1-5. The quilt squares that are *not* labeled are the ones that should be taped to learners' backs. They can use the labeled set of patterns afterward to learn the names of the different patterns.

Activity 2

What Do I See? An Introduction to Tessellations and Symmetry

Leader Notes

This activity is an introduction to the mathematics of quilting, particularly symmetry and tessellations. Learners will discover the connection between quilting and formal mathematical knowledge and skills.

Key Questions

- What are tessellations? Why are tessellations important in quilting?
- What is symmetry? Why is symmetry important in quilting?
- What types of motions can create symmetry?
- How do I determine whether an object has symmetry?

When we hear the word *geometry*, we often think about the study of shapes. However, geometry also involves various properties of shapes and the motion of shapes. Patterns made up of one repeating shape or combination of shapes without any gaps or overlaps are called tessellations. For example, tiles on the floor usually create tessellations. Tessellations are made by the motion or placement of shapes. They are seen in quilting because quilts are usually composed of geometric figures that fit together to create a design. A quilt that is composed of square blocks represents a tesselliation. Why? Because the same figure (a block) is repeated throughout the quilt, and no empty spaces exist between the squares.

Symmetry is another important mathematical concept used in quilting. There are many types of symmetry. We will focus first on line symmetry (also called reflection symmetry). A figure has line symmetry if, when the object is folded, the parts of

Materials Checklist

- ☐ Quilt(s) or pictures of quilts from Activity 1
- ☐ Handout 2-1 (1 per learner)
- ☐ Handout 2-2 (1 per learner)
- ☐ Handout 1-5 (1 per learner or small group)
- ☐ Handout 2-3 (1 per learner)
- ☐ Handout 2-4 (1 per learner)
- ☐ Pencils (1 per learner)
- ☐ Handout 1-2 (1 per learner)

Approximate Time Required

Exploring traditional blocks, 15-20 minutes

Lines of Symmetry, 10 minutes

Flips, Slips, and Slides, 20 minutes

Exploring Quilts, 20 minutes

Environmental Note

Recycle any leftover paper.

What to Do in Advance

- ☐ Read leader notes on Symmetry and Tessellations.
- ☐ Copy Handouts 2-1 through 2-4.
- ☐ Copy the labeled quilt block designs (Handout 1-5) if they were not saved from Activity 1.
- ☐ Have pictures of quilts ready.

the figure are congruent. Here is an example:

In this block, there are four lines of symmetry. Vertical, horizontal, and diagonal lines can be drawn through a figure to indicate symmetry.

When you look at quilts, you often see one shape or design that is repeated. Sometimes the shape or design looks like it has been slid along an invisible line, then repeated. Other times the design looks like it has been turned around a stationary point. Occasionally, the design looks like it has been flipped over. These motions (sliding, turning, or flipping) create symmetry. Each quilt pattern block can exhibit line symmetry. Sometimes the quilt itself can be symmetric.

Handout 2-1 provides learners with some practice identifying lines of symmetry.

Use Handout 2-2 to explore symmetry in some traditional quilt block designs.

Handout 1-5, "Quilt Block Designs," provides learners with examples of traditional patterns from a variety of cultures. Take some time to explore the designs with learners. Have them point out the geometric shapes and how the placement of the shapes creates the design. For example, the Four Patch design is composed of squares, and the Broken Dishes block is created by right triangles. The repetition of shapes creates a pleasing image. Learners should draw a vertical, horizontal, and/or a diagonal line through each block to discover if the patterns have line symmetry. Some of the patterns will not have any form of symmetry. Others may have multiple line symmetries. Look for slides, turns, and flips of shapes.

Use Handout 2-3 to explore different motions that can create symmetry.

Using quilts or pictures of quilts from Activity 1, have learners look at the quilts from the perspective of a mathematician. They will be looking for symmetry, tessellations, and geometric shapes. Give each learner or group a copy of Handout 2-4, which has sample questions they might ask. Give them a few minutes to answer the questions, and then have a group discussion. Be sure to use your mathematics dictionary (Handout 1-2) with this activity.

Activity 3

Tessellating Shapes

Leader Notes

It is the richest source of inspiration that I have ever tapped, and it has by no means dried up yet.
—M. C. Escher

This activity engages learners in further investigations of tessellations. Using the basic definition of a tessellation as a shape or a combination of shapes that covers an entire area without any gaps or overlapping, learners create their own tessellating designs. This activity is a building block for making their own quilt block in Activity 7.

Key Questions

- What roles have tessellations played in history and culture?
- What types of geometric figures can tessellate?
- What are some ways to create a tessellating design?

Tessellating Shapes

Tessellations can be found in many cultures including the Egyptian, Moorish, Roman, Persian, Greek, Byzantine, Arabic, Japanese, Islamic, and Chinese cultures. Coloring techniques, the kinds of shapes used, and the purpose of tessellations vary according to cultures.

The use of tessellations in art and architecture can be traced back to the Sumerian civilization (4,000 B.C.). In ancient Sumeria, tessellated designs were used to decorate many things, including structural supports such as columns and arches.[1] Tessellations are featured a great deal in Islamic art and architecture because of religious beliefs: Islam forbids the use of human subjects in art. Many Islamic artists use two-dimen-

Materials Checklist

- ☐ Colored construction paper (3-5 sheets of different colors per learner)
- ☐ Card stock (1 piece per learner)
- ☐ Scissors (1 per 4 learners)
- ☐ Glue or glue sticks (1 per 4 learners)
- ☐ Handout 3-1 (1 per learner)
- ☐ Handout 3-2 (1 per learner)
- ☐ Clear tape

Approximate Time Required

Tessellating Shapes, 30 minutes

Nibbles and Slides, 30 minutes

Environmental Note

Recycle any leftover paper.

What to Do in Advance

- ☐ Read the activity guide.
- ☐ Read the leader background information on tessellating shapes.
- ☐ Copy Handouts 3-1 and 3-2.
- ☐ Gather materials.

sional geometric patterns to express spiritual ideals.[2] The Moors who conquered Spain used simple shapes in their tessellations. The Romans and the other people of the Mediterranean, however, use detailed illustrations of humans and scenes.[3] The Chinese are known for their tessellating window lattices, which they use to separate rooms or to separate their garden from their home.[4] Dutch artist M. C. Escher, a more contemporary artist, is well known for art based on the use of tessellations.

Structuring this Activity

Use Handout 3-1 to explore which simple geometric figures tessellate. (Tessellated figures cover an entire area without any gaps or overlaps when they are repeated.) Learners are directed to cut out four copies of 11 different shapes, then "play" with the shapes to see which ones can be tessellated. They can fill out the tessellation data sheet based on their experiences in manipulating the cutout shapes.

Handout 3-2 challenges learners to create their own tessellating designs through "nibbles and slides."

After these activities, have learners create tessellated designs with cardboard shapes. They might do this individually or as a group. They might wish to produce one large tessellation or smaller tessellations using a variety of geometric shapes—triangles (right, isosceles, or equilateral), squares, rectangles, hexagons, rhombi, pentagons, octagons, etc.

Provide learners with an assortment of colored construction paper to cut shapes from. They may wish to make a template of each shape in Handout 3-1 to use as a guide so they can trace the shapes onto the paper before cutting them out. Learners then use the colorful shapes to create a design. When finished, they should glue their patterns onto card stock for display.

Activity 4

Kaleidoscope on a Desk! Creating Symmetric Designs

Leader Notes

The essences are each a separate glass, through which the sun of being's light is passed—each tinted fragment sparkles in the sun: a thousand colors, but the light is one.

—Jami (15th Century)

In this activity, learners will expand their investigations of symmetry by making a desktop kaleidoscope. This kaleidoscope, unlike those you may be familiar with, is composed of cutout squares produced by cutting and folding. The desktop kaleidoscope is an attractive expression of symmetry that also honors quilting and paper-cutting arts.

Key Question

- What are some ways to make symmetric designs?

Handout 4-1 contains the directions for this activity. Each learner will need 6 to 12 pieces of card stock or heavy construction paper in a variety of colors. This paper can be any size, but all pieces should be the same size (5 x 5 works well).

Learners make symmetric cutouts in the colored squares. Many different designs can be produced depending on how the squares are folded before they are cut, how many folds are made, and what kinds of cuts are made.

Encourage learners to experiment with different numbers and types of folds while producing their designs. A few folds and large cutouts will produce open squares. More folds and smaller cuts will produce more intricate designs.

By stacking the cutout squares on top of one another in various arrangements, learners can produce many kaleidoscope-like designs. Kaleidoscopes will look better if they include a mixture of large and small cutouts.

Materials Checklist

- ☐ Card stock or construction paper of various colors (6-12 pieces per learner)
- ☐ Card stock, 8-1/2" x 11", for mounting designs (1 per learner)
- ☐ Scissors (1 per learner)
- ☐ Handout 4-1 (1 per learner)
- ☐ Crayons, colored pencils, or markers (1 set per 4 learners)
- ☐ Handout 1-2

Approximate Time Required

Producing kaleidoscope, 20 minutes

Environmental Note

Recycle any leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 4-1.
- ☐ Gather materials.

Activity 5

Symmetry and Tessellation Scavenger Hunt

Leader Notes

Nature seems to take advantage of the simple mathematical representation of the symmetry laws. When one pauses to consider the elegance and the beautiful perfection of the mathematical reasoning involved and contrast it with the complex and far-reaching physical consequences, a deep sense of respect for the power of the symmetry laws never fails to develop.

—C. N. Yang in *Perfect Symmetry: The Search for the Beginning of Time* by Heinz R. Pagels

Learners look for examples of symmetry and tessellations around them, identify the symmetries, and sketch the objects. This scavenger hunt helps learners test their understanding of tessellations and symmetry while discovering that these mathematical concepts are a part of their everyday environment.

Materials Checklist

- ☐ Handout 5-1 (1 per team)
- ☐ Pencils (1 per team)

Approximate Time Required

Varies; allow at least 45 minutes for the hunt

Environmental Note

Recycle any leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 5-1.
- ☐ Make arrangements for learners to have a place to hunt for symmetry and tessellations in their surroundings.

Key Questions

- What types of symmetry are in the world around me?
- Where can I find examples of symmetry in my environment?

There are many ways to conduct a scavenger hunt. Learners can explore their classroom or meeting facility. You can take a field trip to the local park to discover symmetry and tessellations in nature. Learners can do their hunts as individual projects at home. Regardless of the structure, the hunt should encourage increased awareness of and appreciation for symmetry and tessellations in their environment, both natural and constructed.

Each team needs a copy of Handout 5-1. After the hunt, they should share their findings, either in a large group or in smaller groups.

Activity 6

The Way I See It

Leader Notes

This activity engages learners in hands-on exploration of the many ways geometric shapes can be combined to form other shapes and patterns. Both shape and color are important elements to creating quilt patterns. This activity will help prepare learners to design their own patterns.

Key Question

- What are some different ways that colors and shapes can be used to create appealing patterns?

Each learner will need Handout 6-1. They should experiment with selecting colors and shapes to create designs like those illustrated in the handout. Then, they should use pattern blocks to create their own designs. Encourage learners to experiment with different sizes and shapes of pattern blocks to create special effects.

When learners have developed designs they like, they should use the mirrors to see what their designs will look like when tessellated to form a quilt block. To do this, put mirrors around the four sides of the design, forming a square. Looking along the sides and at the reflections shows what the design will look like when tessellated.

When learners are happy with the look of their tessellated designs, have them use the pattern blocks to cut out cardboard templates for the shapes in their design. They can then use the cardboard shapes as templates to cut shapes out of sponge.

Tell learners to place the compressed sponges in water after they are cut out. The sponges will "pop up" or decompress as they

Materials Checklist

- ☐ Handout 6-1 (1 per learner)
- ☐ Pattern blocks (250-piece set per 4-5 learners) or cut out your own from the templates in Handout 6-2
- ☐ Flat, rectangular mirrors (5" x 7" mirrors with a thin plastic frame work well) (4 mirrors for every team of 4-5 learners)
- ☐ Compressed sponges (also called flat sponges or pop-up sponges) (3-4 pieces per team)
- ☐ Cardboard or card stock for cutting out templates
- ☐ Tempera paint—small amounts of several colors to use for sponge painting
- ☐ White paper for painting
- ☐ Water (1 saucer per team)
- ☐ Tape (to tape paper to wall)
- ☐ Clean rags

Approximate Time Required

Making patterns with pattern blocks, checking out with mirrors (20 minutes)

Sponge painting (20 minutes)

Environmental Notes

- ☐ Recycle any leftover paper.
- ☐ Wash rags for reuse.
- ☐ Tightly cap paint for later use.

absorb water. Learners should wring out excess water, then dip the sponge shapes in the appropriate color of tempura paint. They must place the shapes on the paper carefully, press, and hold to make the shape. They repeat the process with the other shapes until their quilt squares are complete.

You might ask learners to paint a "group sampler" by sponge-painting their quilt squares onto a big sheet of paper you've taped to the wall. Or you could ask each learner to sponge paint his or her pattern onto a square piece of paper, then join the squares together to form a sampler.

Invite learners to think about how they will create a quilt block design that has special meaning to them. Ask them to write briefly in response to this question: "If you could be any quilt shape, which one would you be? Why?" Learners should be able to tell why they chose the colors, shapes, and pattern that they did and what their pattern means to them. (For example, "I used mainly green and blue to represent the grass and sky because I like being outdoors.")

In the next activity, learners will use pattern blocks or their own sketches to create their designs from fabric or cardboard.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 6-1.
- ☐ Gather materials.
- ☐ Copy Handout 6-2 on card stock if you are going to use it.
- ☐ Identify wall, blackboard, or other flat surface on which paper can be taped without damage.

Activity 7

Creating a Piece of Myself

Leader Notes

How much piecin' a quilt is like livin' a life! You can give the same kind of pieces to two persons, and one will make a "nine patch" and one'll make a "wild goose chase," and there will be two quilts made out of pieces, and jest as different as they can be. And that is jest the way with livin'. The Lord sends us the pieces, but we cut them out and put 'em together pretty much to suit ourselves, and there's a heap more in the cuttin' out and the sewin' than there is in the caliker [calico].

—Eliza Calvert Hall, *Aunt Jane of Kentucky*

In this activity learners create their own quilt pattern designs based on what they have learned about geometric shapes. They can use either construction paper or fabric. If they use fabric, they can use fusible webbing to iron their designs onto T-shirts, book bags, or other fabric items.

Key Questions

- What are some ways I can use colors and shapes to create a design that expresses something about myself?
- What are some ways I can make this design into a public expression?

There are many ways this activity can be done. For example, if T-shirts or other materials are not available or if resources are limited, learners can paste their block designs on decorated card stock or construction paper. You could combine the blocks to create a paper quilt to decorate your meeting room.

If you are working with younger learners, you may want to precut materials into various geometric shapes. A variety of geometric shapes are found on the templates provided in Handouts 6-2 and 7-1.

Materials Checklist

- ☐ Handout 1-5 (optional, 1 per learner)
- ☐ Handout 7-1 (1 per learner)
- ☐ Pattern blocks (250-piece set per 4-5 learners)
- ☐ Pencils (1 per learner)
- ☐ Fabric for quilt pieces
- ☐ T-shirts, book bags, etc. (1 per learner)
- ☐ Irons (1 per group)
- ☐ Ironing boards (1 per group)
- ☐ Fusible webbing
- ☐ Handout 7-2 (1 per learner)
- ☐ Handout 7-3 (1 per learner)

Approximate Time Required

Making T-shirt, 2 hours

Writing poem, 20 minutes

Environmental Notes

Recycle any leftover paper.

Save leftover fabric and fusible webbing for future projects.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Decide what you will make (T-shirt, book bag, cardboard wall hanging, etc.)
- ☐ Gather materials and/or have learners bring materials in.

Handout 1-5 illustrates a number of traditional block designs.

Allow learners time to experiment with the pattern blocks while creating their designs. If learners are having a hard time creating designs, refer them to Handout 1-5 for inspiration.

Safety Note

If designs are to be ironed onto fabric, you may wish to do the ironing yourself, to prevent burns.

After they have chosen their designs, they will need to trace each shape onto construction paper and cut out these shapes. Then learners should be able to place their shapes together and create their patterns. Once they are satisfied with their designs, they can cut them out of fabric.

Learners will then use fusible webbing to iron their designs onto T-shirts. Fusible webbing is a material used in sewing and craft projects. It allows two pieces of fabric to be stuck together and is used to make the fabric adhere to the T-shirts or book bags. If you did not place the fusible webbing onto the fabric earlier, learners will need to cut it out and place it on the back of each piece.

Handout 7-2 contains letters that learners might wish to add to their designs. This allows them to personalize their T-shirts even more.

Here are a few suggestions to make this activity go more smoothly:

- Provide a limited number of fabric colors (solids and prints) for learners to choose from. This cuts down on disputes over materials.
- Tell learners what the limit is on the number of fabric pieces they can use for their shirts. Or have learners bring scrap fabric from home.
- If using T-shirts or book bags, all should be white or a neutral color.
- Iron the fusible webbing on the fabric before the activity. This will save time.
- Experiment with the iron temperature to find out what works best with the fusible webbing that you are using. Temperatures needed to fuse the fabrics vary. Quilt pieces will soon fall off if learners do not use an appropriate temperature.

After learners have completed their products (T-shirts, book bags, etc.), learners should use Handout 7-3 to write poems about their quilt patterns.

Activity 8

Our Own Stories

Leader Notes

Just as a quilt can bring together many pieces to form a beautiful whole, this activity can bring together many ways of understanding quilting. Encourage learners to discover for themselves the significance of quilting in a place and time period, then share their understandings with the community through exhibitions, displays, presentations, or a fair.

Key Question

- Key questions are developed by the learners themselves.

A number of short books and Internet sites are listed on Handout 8-1. If you have Internet access, a wealth of information is easily available. Libraries are also good sources for materials.

Encourage learners to search their own culture or region, or a place that has some personal or familiar meaning. They could follow up on questions they developed during the project. Learners should address the following questions for the place and time they select:

- In what time period were these quilts made?
- Who made quilts at the time and place you are studying?
- For what purposes were quilts made? Have these purposes changed over time? (Expression, artwork, communication, warmth, to raise money for a charity or cause, for gifts, for decorative purposes, etc.)
- Were there certain quilt block designs, patterns, and colors used during the time period you studied?
- What interesting information is available about the role of quilts in the culture of that place and time?

Encourage learners to develop a presentation with visual elements (handout, poster, computer programs such as PowerPoint and Hypermedia, etc.). Visual elements can often communicate information better and faster than words alone. You could have learners present their research to the rest of the group and ask for feedback. This would help them prepare for sharing their work with the broader community.

Materials Checklist

- ☐ Handout 8-1
- ☐ Access to various books, magazines, and/or Web sites on quilting

Approximate Time Required

Time varies depending on depth of research and type of presentation.

Environmental Note

Recycle any leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Determine with your group what type of presentation you will do (exhibition, display, fair, etc.).
- ☐ Arrange for access to a library and/or the Internet.

Materials Summary

Activity 1

- ☐ Quilter(s) who have agreed to be interviewed
- ☐ Handout 1-1 (1 per learner)
- ☐ Handout 1-2 (1 per learner)
- ☐ Handout 1-3 (optional, 1 per learner)
- ☐ Handout 1-4 (optional, 1 per learner)
- ☐ Handout 1-5 and safety pins or tape (optional)
- ☐ Quilts (learners are invited to bring them from home)
- ☐ Cameras with flashes and film (at least 1 per group)
- ☐ Pencils (1 per learner)

Activity 2

- ☐ Quilt(s) or pictures of quilts from Activity 1
- ☐ Handout 2-1 (1 per learner)
- ☐ Handout 2-2 (1 per learner)
- ☐ Handout 1-5 (1 per learner or small group)
- ☐ Handout 2-3 (1 per learner)
- ☐ Handout 2-4 (1 per learner)
- ☐ Pencils (1 per learner)

Activity 3

- ☐ Colored construction paper (3-5 sheets of different colors per learner)
- ☐ Card stock (1 piece per learner)
- ☐ Scissors (1 per 4 learners)
- ☐ Glue or glue sticks (1 per 4 learners)
- ☐ Handout 3-1 (1 per learner)
- ☐ Handout 3-2 (1 per learner
- ☐ Clear tape

Activity 4

- ☐ Card stock or construction paper of various colors (6-12 pieces per learner)
- ☐ Card stock, 8-1/2 x 11, for mounting designs (1 per learner)
- ☐ Scissors (1 per learner)
- ☐ Handout 4-1 (1 per learner)
- ☐ Crayons, colored pencils, or markers (1 set per 4 learners)

Activity 5

- ☐ Handout 5-1 (1 per team)
- ☐ Pencils (1 per team)

Activity 6

- ☐ Handout 6-1 (1 per learner)
- ☐ Pattern blocks (250-piece set per 4-5 learners) or cut out your own from the templates in Handout 6-2
- ☐ Flat, rectangular mirrors (5" x 7" mirrors with a thin plastic frame work well) (4 mirrors for every team of 4-5 learners)
- ☐ Compressed sponges (also called flat sponges or pop-up sponges) (3-4 pieces per team)
- ☐ Cardboard or card stock for cutting out templates
- ☐ Tempera paint–small amounts of several colors to use for sponge painting
- ☐ White paper for painting
- ☐ Water (1 saucer per team)
- ☐ Tape (to tape paper to wall)
- ☐ Clean rags

Activity 7

- ☐ Handout 1-5 (optional, 1 per learner)
- ☐ Handout 7-1 (1 per learner)
- ☐ Pattern blocks (250-piece set per 4-5 learners)
- ☐ Pencils (1 per learner)
- ☐ Fabric for quilt pieces
- ☐ T-shirts, book bags, etc. (1 per learner)
- ☐ Irons (1 per group)
- ☐ Ironing boards (1 per group)
- ☐ Fusible webbing
- ☐ Handout 7-2 (1 per learner)
- ☐ Handout 7-3 (1 per learner)

Activity 8

- ☐ Handout 8-1
- ☐ Access to various books, magazines, and/or Web sites on quilting

[blank page]

Pieces of Mine

Handout 1-1

Quilts as Art and Life

You will be interviewing a quilter or series of quilters about the art they make and why they make it. You will then use the information from the stories the quilters tell to write articles about the quilters and their quilts for a newsletter, a scrapbook, or the World Wide Web.

To make sure you get enough interesting information to write good stories, you should develop some questions to ask the quilter you interview.

Use your list of questions to create a form to help you record the quilter's responses. The following list provides some sample topics to think about as you develop your own questions:

- Why does the quilter do quilting?
  - Social reasons?
  - Economic reasons?
  - Historical reasons?
  - Political reasons?
  - Recreational reasons?
  - Therapeutic reasons?
  - Reasons related to family or tradition?
  - Other reasons?
- How did the quilter get interested in quilting?
- How did the quilter learn to quilt? Who taught the quilter? Why did these people teach the quilter to quilt?
- How long does it take to learn to quilt?
- Why does the quilter like quilting?

Ask quilters to tell the stories of the quilts they brought or their favorite quilts. Why was that quilt chosen? When was it done? Who was involved in making the quilt? Where did the fabric for the quilt come from? Why was that pattern chosen? Why was that fabric chosen?

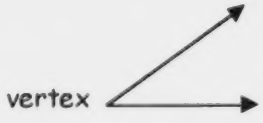
Pieces of Mine

Handout 1-2

My Mathematics Dictionary

Angle

An angle is formed by two rays with the same endpoint. The endpoint is called the vertex.



Think of a crocodile opening its mouth. The larger her mouth, the larger the angle!

The size of the opening of the angle is measured in degrees.
Protractor: **Print pages 24-25 to measure angles. To print, load the pages in the printer, then print from Word onto these pages.**

A right angle (or square angle) measures 90°.

Can you draw a 180° and a 360° angle?

Circle

A circle is a set of points that are all the same distance from the center.

©S. A. Cohen, 1999

Congruent

Two figures are said to be congruent if they have the same size and shape.

(You are allowed to move the shapes around with slides, flips or turns!)

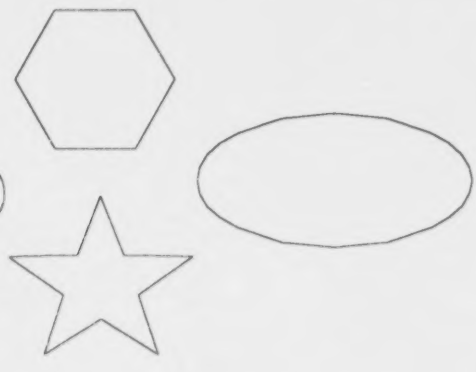
The three right triangles below are congruent.

Geometric Figure

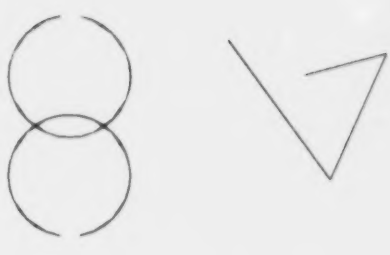
A geometric figure is a combination of points, lines, curves, or planes.

A closed shape is a figure that encloses an area.

These shapes are closed.



These two shapes are not closed.

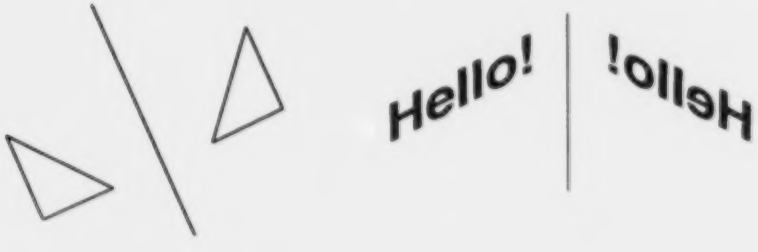


Motions

A motion of a shape or design is the movement of the shape or design by either a slide, flip, or turn. The size and shape are not changed by these movements.

slide A slide is a movement in which a shape or design is moved a certain distance in a certain direction. (Think about the motion of opening a drawer.) Example: Cut out a square and slide it to the right 5 cm. (or about 2 inches.) The illustration below shows the slide of a square to the right.

flip A flip is a movement in which a shape or design is reflected across a line Ñ it looks like it has been flipped over! Have you ever noticed how things seem ÒbackwardÓwhen you look at your reflection in a mirror? This is a real-life example of a flip. In mathematics, a flip is often called a reflection or mirror reflection. Below are two examples of a design that has been flipped.

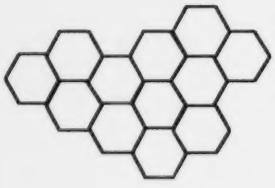


turn A turn is a motion in which an image or design is turned around a point. A real-life example of a turn is when you turn a door handle. In the illustration below, the heart turns clockwise around a point located at the tip of the heart.

Pattern

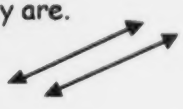
A pattern is a sequence of numbers, shapes, objects, events, or ideas that repeat in some way.

Here is a pattern that bees make:



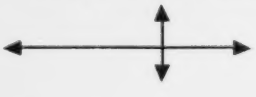
Parallel

Two lines are said to be parallel if they won't ever intersect or cross, no matter how long they are.



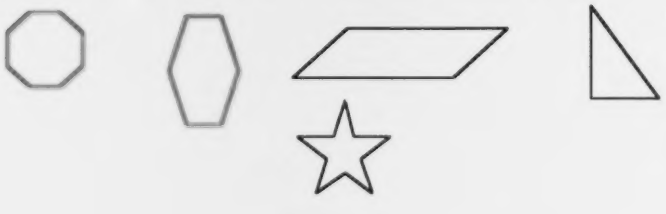
Perpendicular

Two lines are said to be perpendicular if the angle they form where they cross or intersect is 90°.

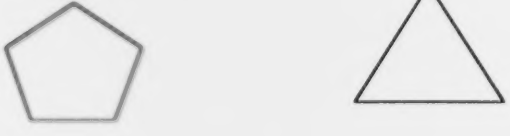


Polygon

A polygon is a closed two-dimensional shape whose sides are line segments. It must have at least three sides, but may have more. In a regular polygon, all sides are equal (all the same) in length and its angles all measure the same number of degrees. The five shapes shown below are polygons.



The two polygons shown below are regular.



A triangle is a polygon with 3 angles and 3 sides.

Equilateral triangles have three congruent (equal) sides.
(Also, each of the three angles measures 60°.)

Isosceles triangles have at least two congruent sides.

Obtuse (lopsided) triangles have one angle that is bigger than 90°.

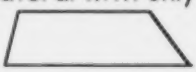
Acute triangles have all three angles measuring less than 90°.

Right triangles have one 90° angle.

A quadrilateral is a polygon with 4 sides.

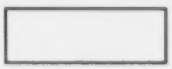
A rhombus is a quadrilateral with all sides the same length and opposite sides are parallel.

A trapezoid is a quadrilateral with only one set of parallel sides.

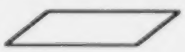


A square is a quadrilateral that has four right angles and four equal sides. (A square is a special case of a rhombus.)

A rectangle is a quadrilateral that has four right angles and opposite sides have the same length.



A parallelogram is a quadrilateral with two pairs of parallel opposite sides. Also, opposite sides are the same length.



A pentagon is a polygon with 5 sides.

A hexagon is a polygon with 6 sides.

A heptagon is a polygon with 7 sides.

An octagon is a polygon with 8 sides.

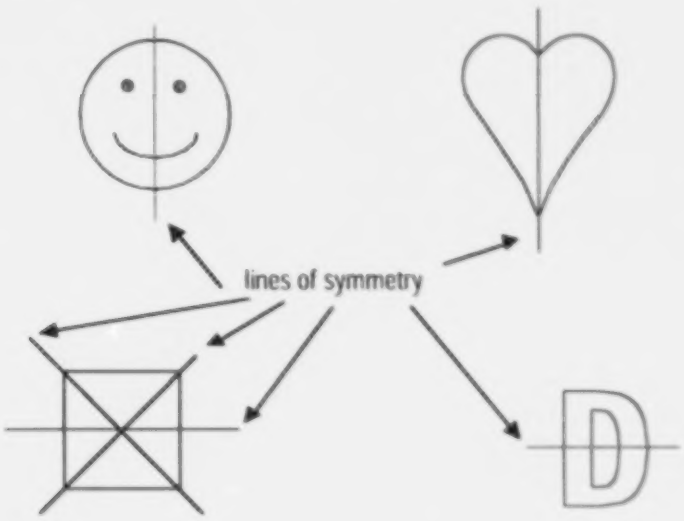
Problem Solving Strategies

Here is a list of strategies that might help solve some mathematical problems.

- draw a picture
- make a list
- look for patterns
- make a table, chart, or graph
- try a similar problem
- try a simpler problem
- work backwards
- make a guess and check

Symmetry

Something has a line of symmetry if one (or more) lines can be drawn to divide it into parts that are mirror images of one another. A line of symmetry acts like a mirror.

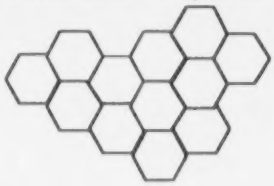


Something has rotational symmetry if you can turn it or rotate it (less than 360°) and it still looks the same.
These flowers all have rotational symmetry:

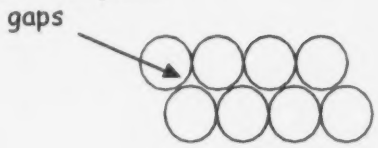
Tessellation

Shapes tessellate a flat surface (a plane) if they completely cover the surface without leaving any gaps (holes) and without overlapping. Many quilt patterns are examples of tessellations.

Regular hexagons tessellate the plane. (Buzz! Buzz!)



Circles do not tessellate the plane.

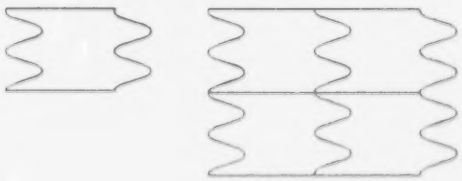


Regular pentagons will not tessellate.

House pentagons will tessellate.

This curved shape will also tessellate.

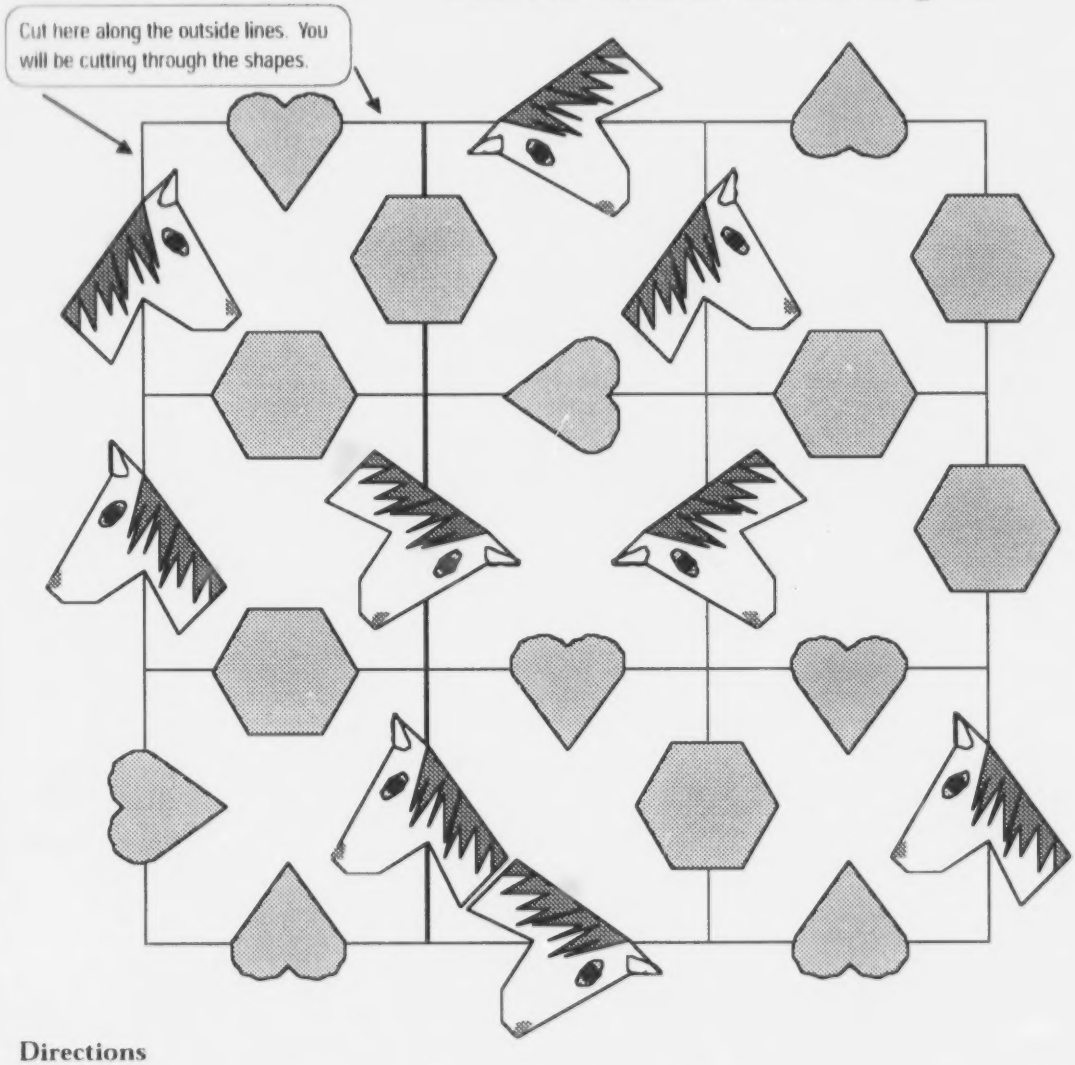
Can you guess how it was made?



Pieces of Mine

Handout 1-3

Horses, Hearts, and Hexagons



Directions

1. Cut out the large square. Don't worry that you will be leaving "halves" of the horses, hearts, and hexagons on the outside.
2. Cut the large square into nine smaller squares by cutting on the lines. Again, you will be cutting through the horses, hearts, and hexagons.
3. Try to put your puzzle back together. The puzzle is harder than it looks. You may have to slide or turn the pieces around.
4. Let your friends and family try to solve your puzzle.

©S. A. Cohen, 1999

Pieces of Mine

Handout 1-4

"Quilting Bee" Directions

- Choose an unlabeled quilt pattern from Handout 1-5, "Quilt Block Designs." Don't show anyone which pattern you select.
- Cut out the square you selected. Tape or pin it on the back of the person to your right.
- Try to find out which pattern you have by asking other players questions. However, you may ask only yes-or-no questions.
- You may ask only two questions of any one person—then you have to ask someone else.
- When you figure out which pattern you have, ask someone to take the pattern off your back. Place the pattern below. Label it.

Write down two questions you asked that really helped you figure out which shape you had.

_____

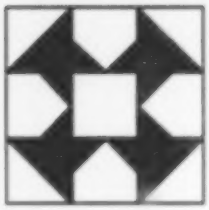
_____

Pieces of Mine

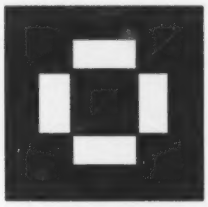
Handout 1-5

Quilt Block Designs

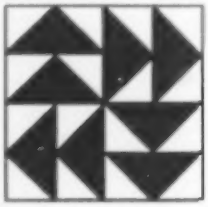
A Dandy



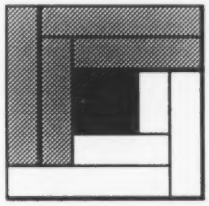
Antique Tile



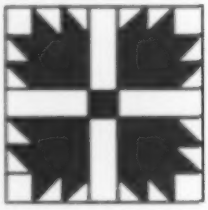
Dutchman's Puzzle



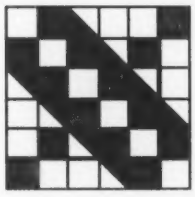
Crossroads



Bear Paw

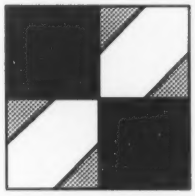


Jacob's Ladder

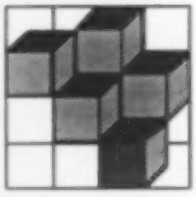


Arkansas Crossroads

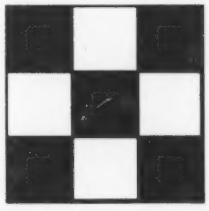
Arkansas Crossroads (rotated)



Tumbling Blocks



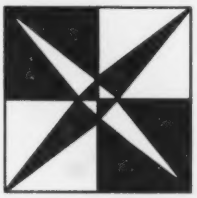
Nine Patch



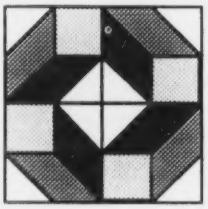
Pieces of Mine

Handout 1-5

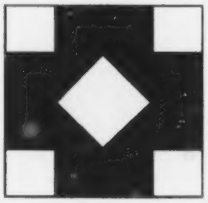
Crossed Canoes



Tumbling Blocks

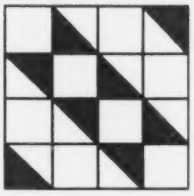


Fair and Square

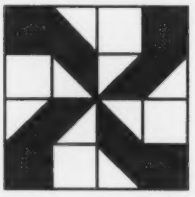


Log Cabin

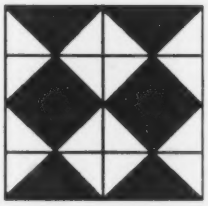
Bow Ties



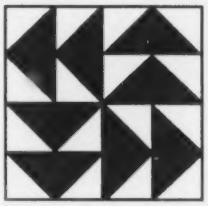
Clay's Choice



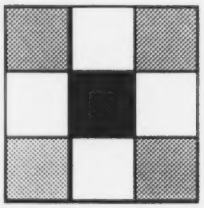
Hour Glass



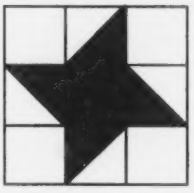
Flying Geese

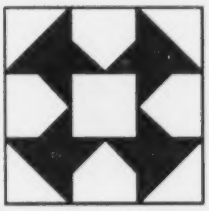
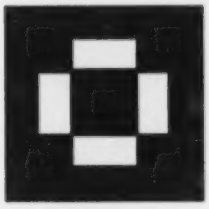
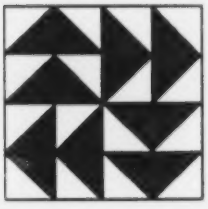
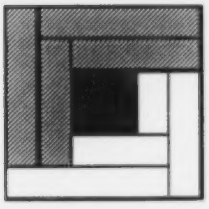
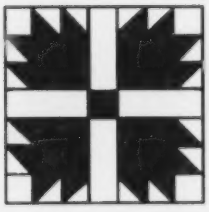
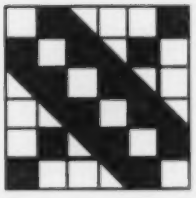


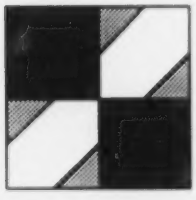
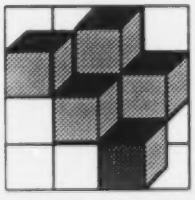
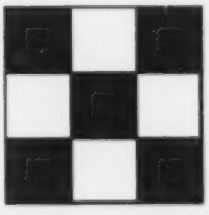
Nine Patch (with different colors)

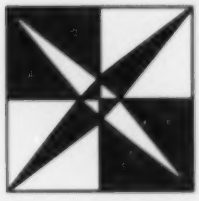


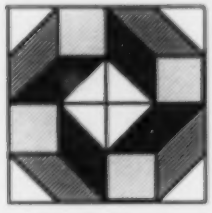
Friendship Star

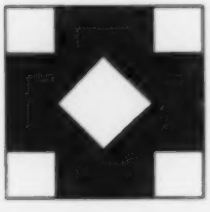


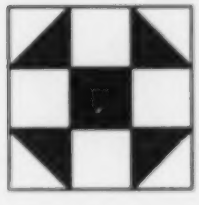







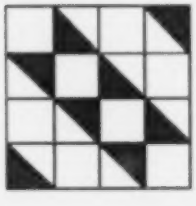




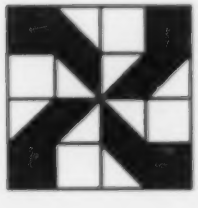


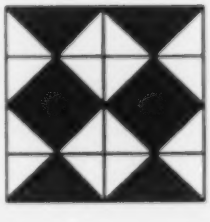


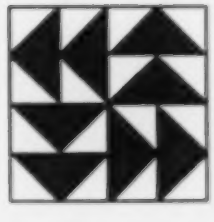


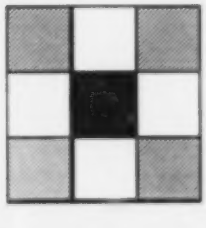


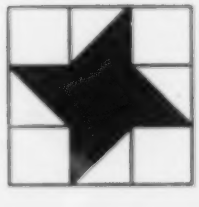








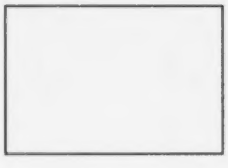




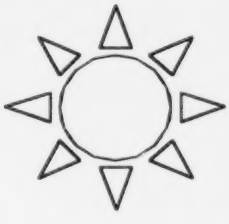
Pieces of Mine

Handout 2-1

How many lines of symmetry can you find?

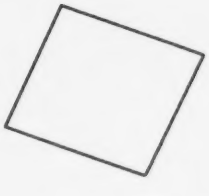


____ lines

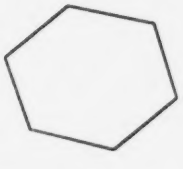


____ lines

____ line

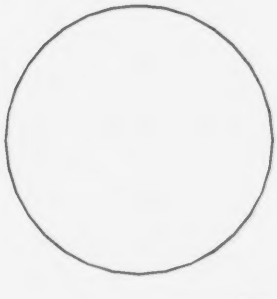


____ lines



____ lines

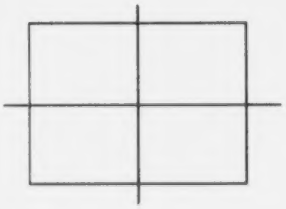
____ lines



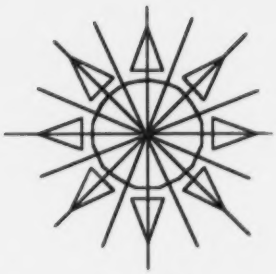
____ lines

Answer Key

How many lines of symmetry can you find?

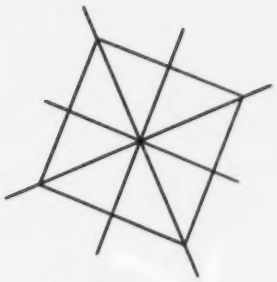


2 lines

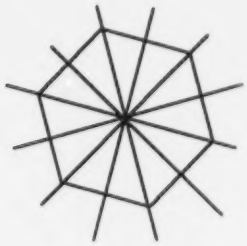


8 lines

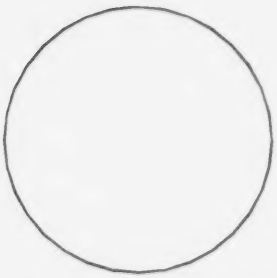
1 line



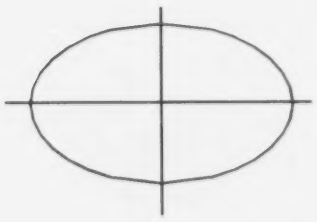
4 lines



6 lines



Infinite number of lines



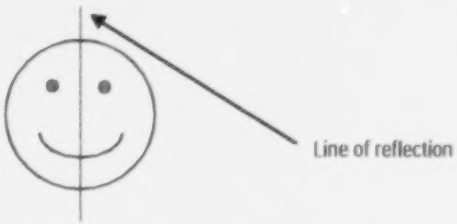
2 lines

Pieces of Mine

Handout 2-2

Symmetry in Block Designs

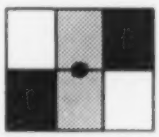
A shape or design is said to have a mirror reflectional symmetry or line of symmetry if you can draw a line through the shape or design so that half of the figure on one side is a "mirror image" of the other. (There might be more than one line.) The "smile" has only one line of reflection.



Another way of looking at it is one half is a "flip" of the other half.

****

A shape or design is said to have rotational symmetry if you can turn the shape or design around a point (for example, a $^1/_2$ turn, $^1/_3$ turn, or $^1/_4$ turn) and have it end up looking the same. If you turn this design half way around the middle circle, it ends up looking like when you started. (This design does not have any lines of symmetry. Can you see why?)



****

The next page has some examples of traditional block quilt patterns.

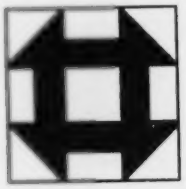
Which of the patterns have lines of symmetry? Draw the lines of symmetry.

Which have rotational symmetry?

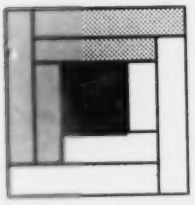
Do any have both?

©S. A. Cohen, 1999

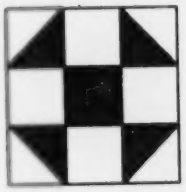
1. Monkey Wrench



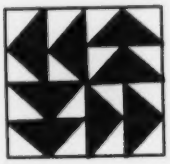
2. Crossroads



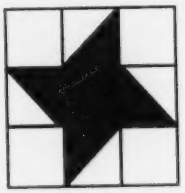
3. Log Cabin



4. Flying Geese



5. Star

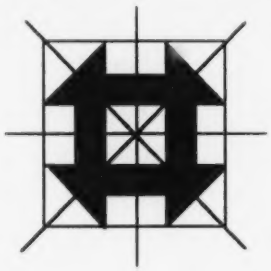


Pattern A pattern is a
repeat in som

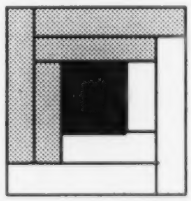
Here is a patt

Answer Key

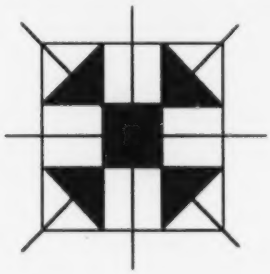
1. Monkey Wrench. Four lines of symmetry. 4-fold rotational symmetry. (That means you can make $^1/_4$ turns and have it still look the same.)



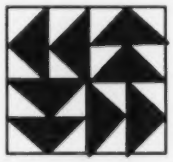
2. Crossroads. Believe it or not, this pattern has no lines of symmetry. At first it looks like it should have two down the diagonal. Look closer at how the pieces are patched together at the corners. (You can use a mirror to help see the difference.) Because of the shading and the different sizes of the pieces around the middle square, it does not have any rotational symmetry either.



3. Log Cabin. This design has 4 lines of symmetry and 4-fold rotational symmetry (you can make $^1/_4$ turns and have it look the same).



4. Flying Geese. Flying Geese has no line of symmetry but it does have 4-fold rotational symmetry (you can make $^1/_4$ turns and have the design look the same).



5. Star. This pattern has no lines of symmetry but it does have 4-fold rotational symmetry (you can make $^1/_4$ turns and have the design look the same).

Pieces of Mine

Handout 2-3

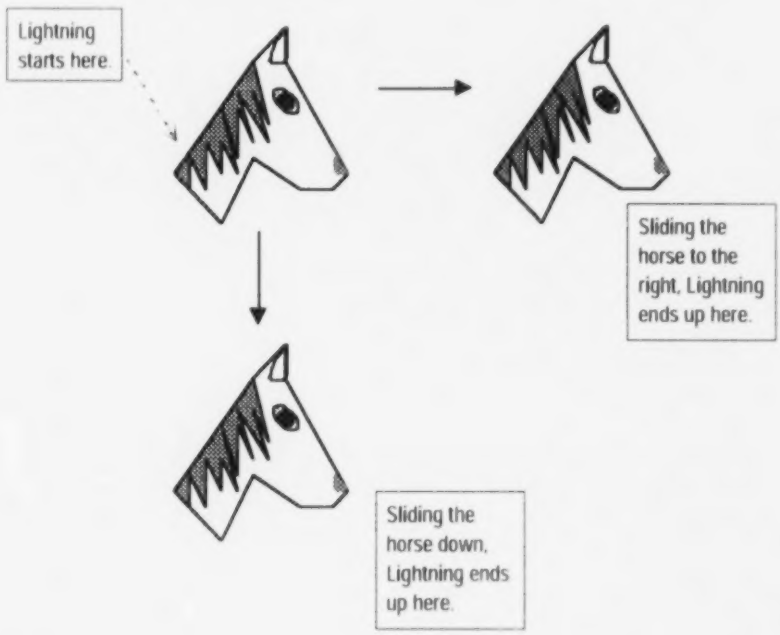
Slides, Turns, and Flips

Step 1. Cut out the horse. (By the way, the horse's name is Lightning because she can turn, flip, and move like lightning.)

Step 2. "Slides"

Use your cutout to trace the horse. Slide it 5 cm to the right.

Where would Lightning end up if you slid it 5 cm down?

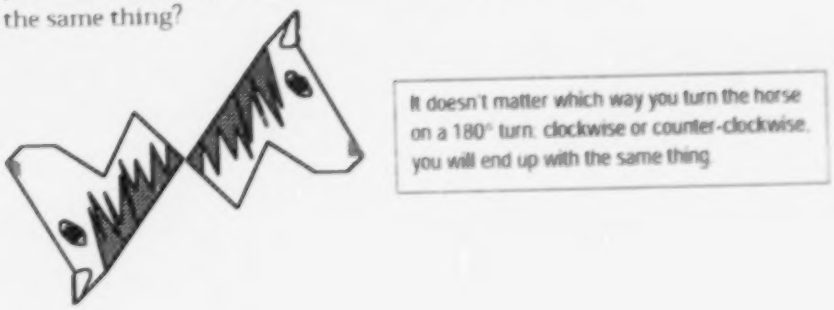

Lightning starts here.
Sliding the horse to the right, Lightning ends up here.
Sliding the horse down, Lightning ends up here.

©S. A. Cohen, 1999

Step 3. "Turns"

Use your cutout horse to show what the horse would look like if you turned it clockwise a quarter turn (90°) around the end of its mane.

Next, make Lightning do a "180"—turn your horse a half turn or 180°. Does it matter if you turn Lightning clockwise or counterclockwise? Do you end up with the same thing?


It doesn't matter which way you turn the horse on a 180° turn: clockwise or counter-clockwise, you will end up with the same thing.

Finally, what happens when Lightning does a "360"—turns around in a complete circle?

Step 4. "Flips"

What happens when Lightning looks in a mirror? Suppose the black striped line is a mirror. Draw what Lightning sees. (Look at the example of the dog.)

Make sure the horse and her reflection are the same distance from the mirror. Sometimes it helps to pick a certain point (like the ear or nose) and check.

Pieces of Mine

Handout 2-4

What Do I See?

Directions: Carefully observe the quilts that are on display or the photos you took earlier, and answer the following questions for each quilt.

1. What basic shapes are used to make the designs on the quilt? Are these shapes all the same size? Same color?

2. Do the shapes create any tessellations? If so, how?

3. Do the shapes in the blocks exhibit symmetry? What type of symmetry? Does the quilt as a whole exhibit symmetry?

Pieces of Mine

Handout 3-1

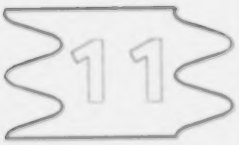
Directions:
Fold your paper in half and then in half again.
You will be cutting out four congruent "copies"
of each shape at one time.

©S. A. Cohen, 1999

6
7
8
9
10
11

Name of Polygon?	Tessellates? Yes or No	Draw an example.

Name of Polygon?	Tessellates? Yes or No	Draw an example.

Name of Polygon?	Tessellates? Yes or No	Draw an example.
		

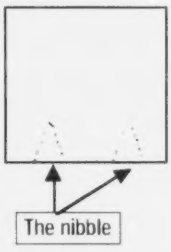
Pieces of Mine

Handout 3-2

Nibbles and Slides

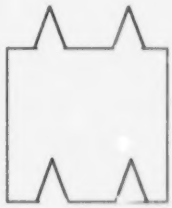
Begin with the square on the last page of this handout. Nibble a little off of one side and slide it to the opposite slide. Use clear tape to tape your nibble to the opposite side. Then color in a design. Show that your design tessellates by drawing the tessellation.

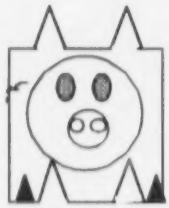
Example 1.



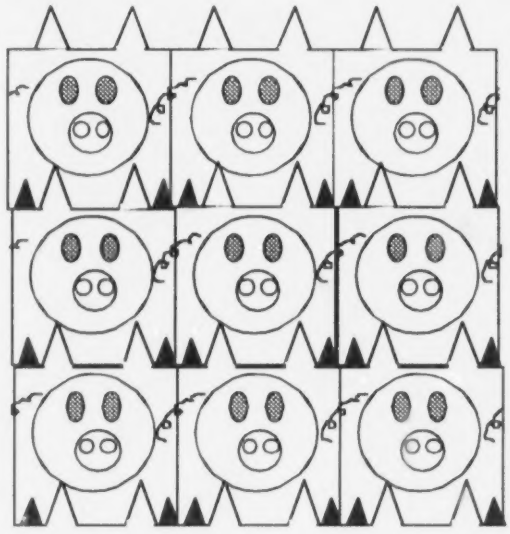
Step 1
Nibble a bit from one side.

Step 2
Slide the "nibble" to the opposite side.





Step 3
Color in your design.



Step 4
Show that your design tessellates by drawing the tessellation.

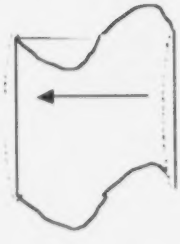
©S. A. Cohen, 1999

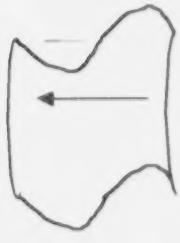
Try making "nibbles" from several sides.

Example 2.

Step 1
Nibble from the top and slide to the bottom.

Step 2
Nibble from the bottom and slide to the top.



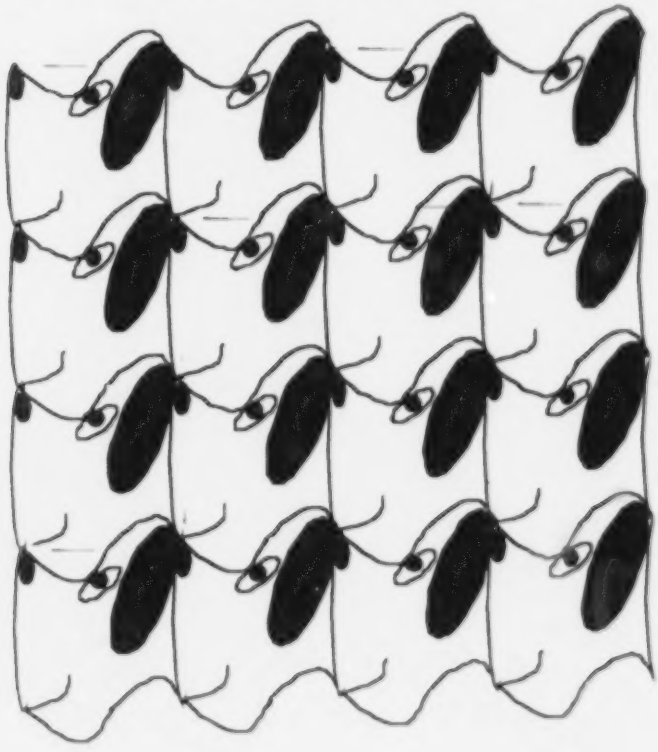


Step 3
Nibble from the right side and slide it over to the left side.

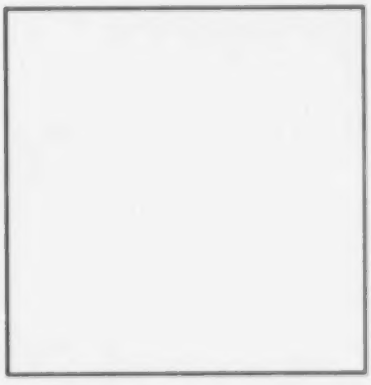
Step 4
Color your design

Step 5

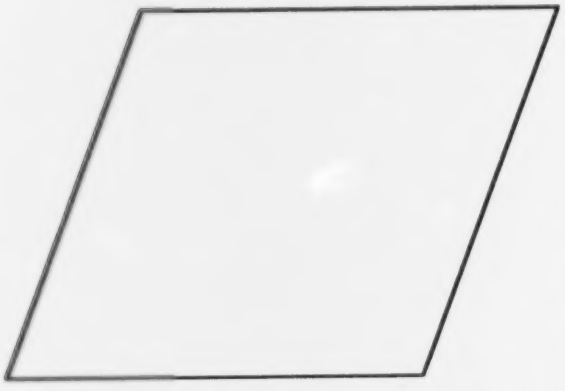
Show that your design tessellates and draw the tessellation. (Sometimes it helps to cut out the object and use it to help trace your tessellation.)

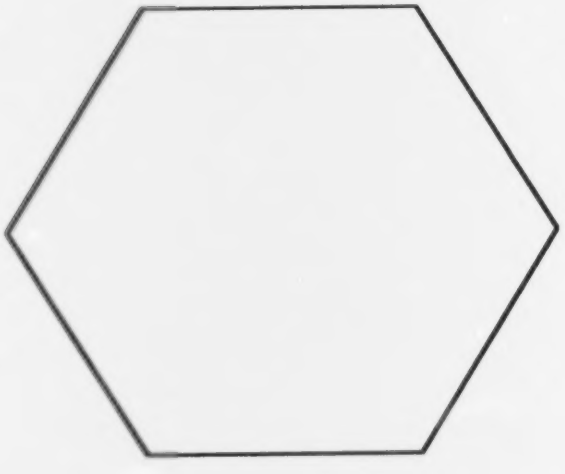


Use the square below to create your own tessellations.



Try the nibble method with a parallelogram or hexagon.





Pieces of Mine

Handout 4-1

Creating Symmetric Designs

Cut 6 to 12 squares of colored paper of the same size.

Select a square and fold the square in two to create two rectangles.

Use scissors to cut designs along the folded side of the figure. Make fairly large cuts.

Unfold the paper and discover the symmetrical designs that you have created.

Repeat this process for each piece of paper. Experiment with different numbers of folds and types of cuts to create variations in your design.

When you have a small number of folds, larger cuts tend to allow for better overall designs. More folds and smaller cuts create more intricate designs.

Stack the squares to see the different quilt designs created. Shuffle the stacks so that the squares are in different orders.

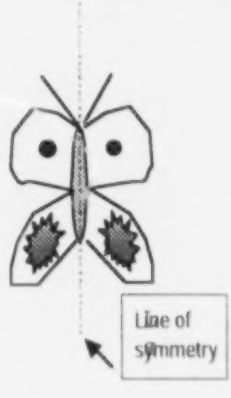
When you get your cards in an order you like, you can glue your desktop kaleidoscope onto card stock. However, you might want to leave it unglued and use a plate stand or other holder to display your desktop kaleidoscope. That way, you could change the designs from day to day.

Pieces of Mine

Handout 5-1

Scavenger Hunt: Symmetry and Tessellations

On this adventure you will be searching for elements in your environment that contain symmetry or create tessellations. Record and sketch your discoveries on the chart below.

What you need to find	Where you found it	Additional Observations	Sketch of what you found
Example. Find an example of a tessellation of rectangles.	The ceiling tiles of our classroom. The rectangles are put together so that they cover the ceiling without any gaps or overlap. (I'm glad there weren't any gaps because it was raining outside when I made the observation and I would have gotten wet!)	There are two lines of symmetry in each rectangle. Each rectangle has rotational symmetry because you can turn the rectangles around 180° and they look the same.	Ceiling Tiles
Example. Find something with one line of symmetry.	On the flowers outside our room, we observed a butterfly with one line of symmetry.	The butterfly had one line of symmetry down the middle but no rotational symmetry. We also saw other curved shapes such as an oval for its body.	Butterfly 

©S. A. Cohen, 1999

BEST COPY AVAILABLE

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#1 Find an example of something with two lines of symmetry			
#2 Find an example of something with rotational symmetry			
#3 Find an example of something with rotational symmetry but no reflectional symmetry			

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#4 Find an example of something with reflectional symmetry but no rotational symmetry.			
#5 Find an example of a tessellation involving only one shape.			
#6 Find an example of a tessellation involving two or more shapes.			

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#7 Find a logo with reflectional symmetry.			
#8 Find an example of a tessellation of octagons and squares.			
#9 Find a hubcap with rotational symmetry but no reflectional symmetry.			

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#10 Find an example of a tessellation using both quadrilaterals (four-sided polygon shapes) and triangles.			
#11 Find an example of a tessellation only using hexagons (six-sided polygon shapes).			
#12 Find an example of a tessellation only using triangles.			

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#13 Find an example of a wallpaper pattern that shows the sliding of shapes. That is, the shapes are repeated in a sliding motion. 			
#14 Find an example of a pattern that shows the turning of shapes. 			
#15 Find an example of a pattern that shows the flipping of shapes. 			

What you need to find	Where you found it	Additional Observations	Sketch of what you found
#16 Find an example of a tessellation where some of the shapes are rotated.			
#17 Find an example of a tessellation with reflectional symmetry.			
#18 Find an example of a tessellation involving four or more different shapes.			

Pieces of Mine

Handout 6-1

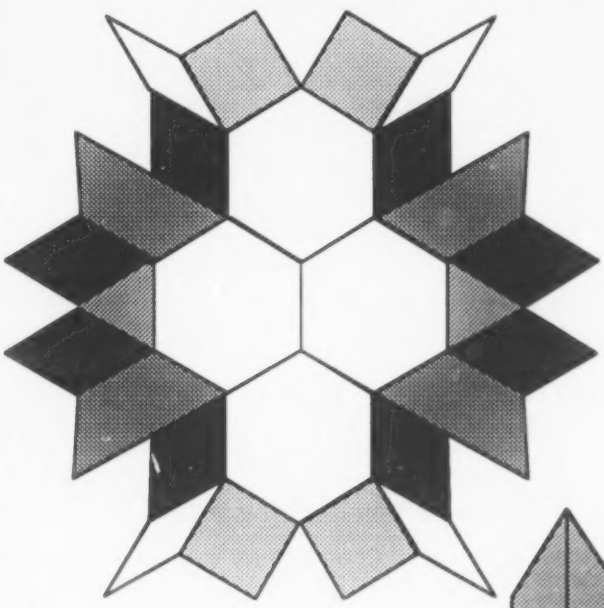
Sample Pattern Block Patterns

Use your pattern blocks to re-create larger versions of the two designs below.

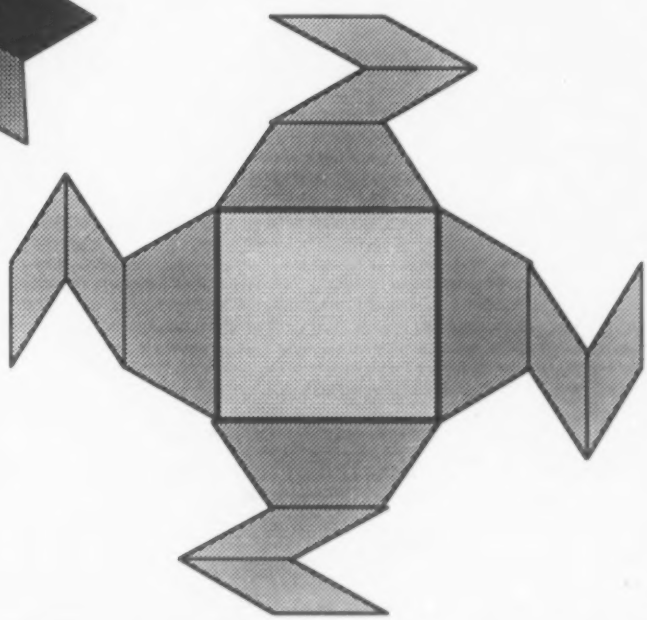
Be careful with the middle in design #2 – the middle may be "tricky."

Do either of the designs have any symmetry? What kind?

Design #1



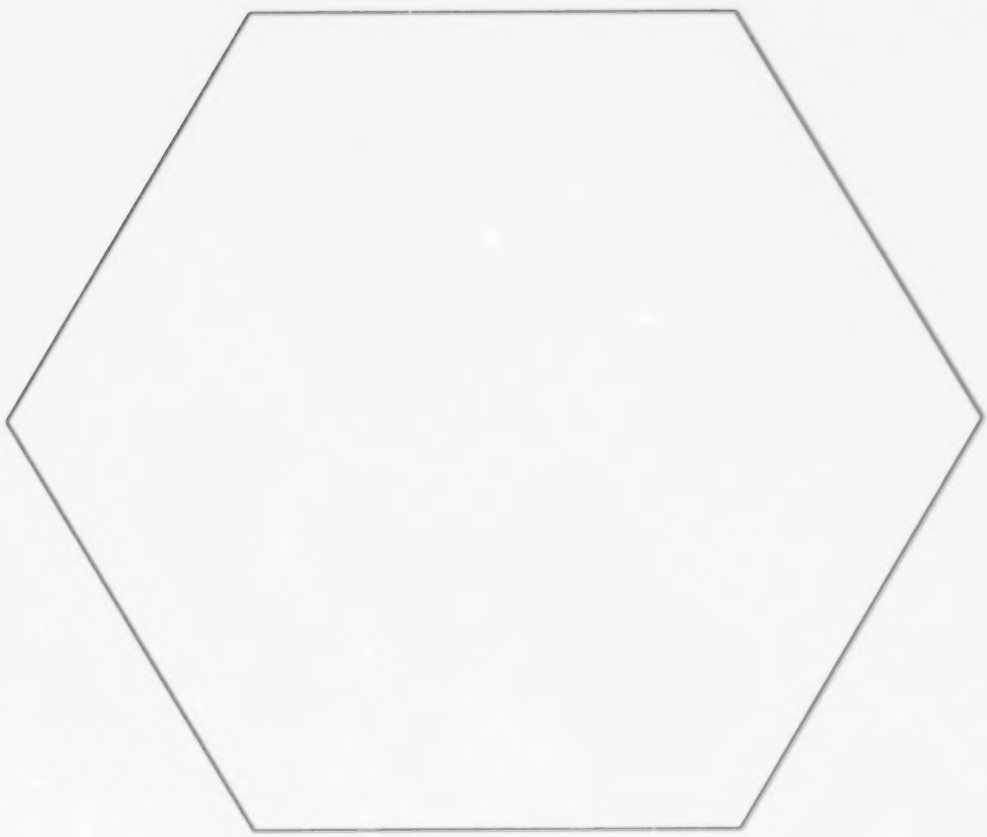
Design #2



Design #3

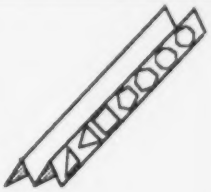
Use your pattern blocks to fill in this hexagon. The only rules are that you have to fill it in completely (you can't leave any gaps) and you can't go outside the hexagon.

Have fun!

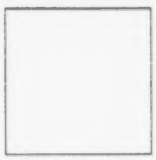


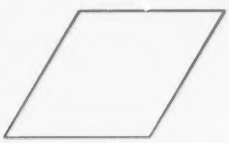
Pieces of Mine

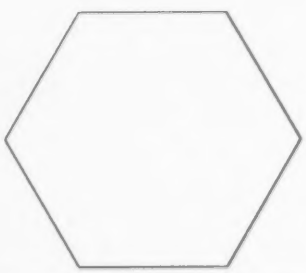
Handout 6-2



Pattern Blocks



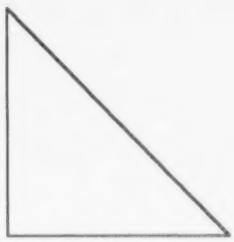


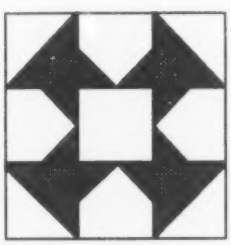


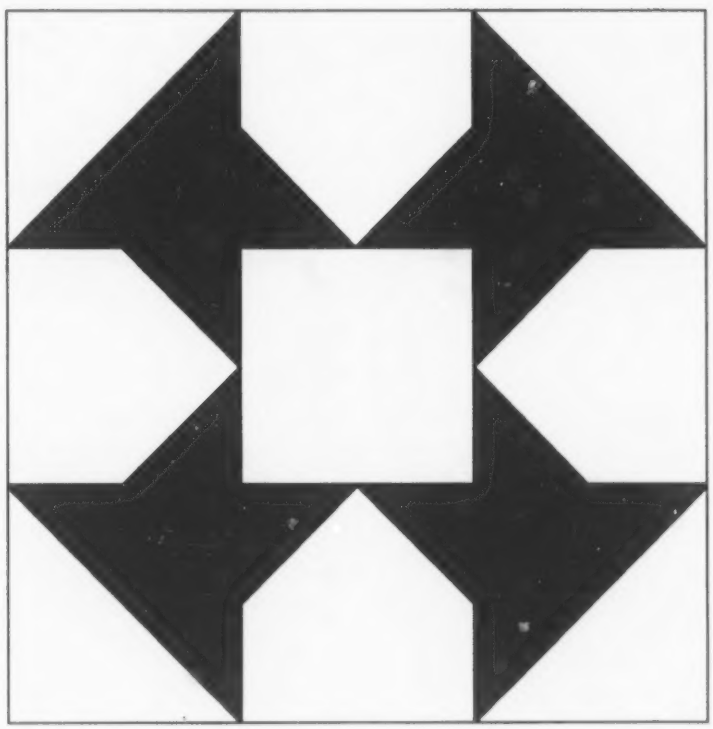
Pieces of Mine

Handout 7-1

More Pattern Blocks







Pieces of Mine

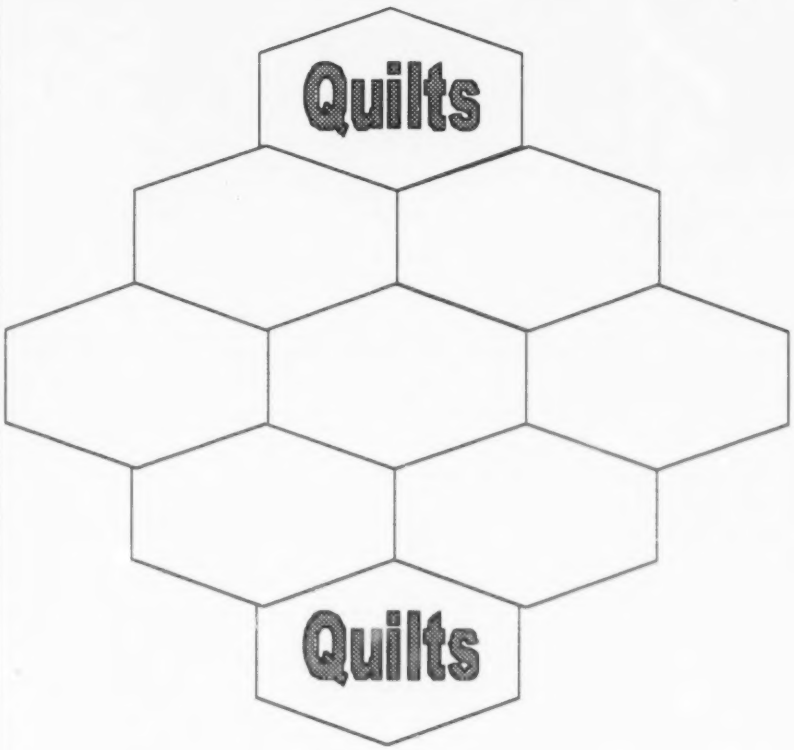
Handout 7-2

Reverse Letters

MNOP
QRST
UVW
XYZ

Handout 7-3

A Quilting Poem



Two uses of quilts

Three shapes found in quilts

Two properties of quilts

©S. A. Cohen, 1999

Pieces of Mine

Handout 8-1

Some Resources on Quilting

Internet Sites

The Mathematical Art of M.C. Escher

http://www.mathacademy.com/platonic_realms/minitext/escher.html

The Poetry and Prose of Quilting

http://ttsw.com/History/PoetryAndProsePage.html

Quilt History

http://needlearts.dm.net/quiltbee/qbqhisto.htm

Quilting: the Fabric of Women's History

http://www.suite101.com/articles/article.cfm/9160

A wealth of quilting info and links, including information on traditional patterns

http://ttsw.com/MainQuiltingPage.html

Quilting in fiction—great resources for integrating reading, math, science, and quilting

http://www.nmt.edu/~breynold/quiltfiction.html

The Virtual Quilt—Lots of info and links on quilting

http://www.tvq.com/

Includes a section on computers and quilting

http://www3.ns.sympatico.ca/thekarls/thekarls.html

A long list of quilting links and pictures

http://www.his.com/~judy/quiltart.htm

Pieces of Mine

Notes

1. Johnson, 1993.
2. Bowes, n.d.
3. Bithner, 1998
4. Bowes, n.d.
5. Leigh, 1997.
6. Lakota Star Quilts, 1997.
7. Hawaiian Quilts, n.d.
8. Johnson, 1992.
9. Drudding, 1992
10. Core Knowledge Foundation, 1997.
11. Norman, n.d.
12. Core Knowledge Foundation, 1997.
13. Alejandre, 1998.

Pieces of Mine

Bibliography

Alejandre, Suzanne. *Historical and Geographical Connections for Tessellations and Tilings*. 18 July 1998. http://forum.swarthmore.edu/sum95/suzanne/historytess.html (8 July 1999).

Bittner, Terrie. "Quilting: The Fabric of Women's History." *Women's History*. 6 September 1998. http://www.suite101.com/articles/article.cfm/9160 (8 July 1999).

Bowes, Lisa. *Quilts: A History of Women and Communication in the 19th Century*. http://magenta.com/~lisabee/quiltcom.html (8 July 1999).

Core Knowledge Foundation. "Slip Sliding through Tesselations—Geometry." 1997. http://www.coreknowledge.org/CKproto2/resrcs/lessons/4geomath1.htm (8 July 1999).

Drudding, Susan. "Quilts & Quilters in Japan." *Quilting*. 23 June 1997. http://quilting.miningco.com/library/weekly/aa062397.htm?pid=2731&cob=home (8 July 1999).

Johnson, Julie. "History of Quilting." *Tales Out of School*. April 1993. http://www.emporia.edu/cgps/tales/quilte~1.htm (8 July 1999).

"Hawaiian Quilts." *World Wide Quilting Page*. http://ttsw.com/History/HawaiianQuilting.html (5 July 1999).

"Lakota Star Quilts." *Ma'inngun Family Education Center: Classes at Migizi*. 1997. http://migizi.org/inc/fec/quilt.html (8 July 1999).

Leigh, Jamie. "African American Quilting Traditions." *Southern Quilting: One Hundred and Fifty Years of Shared Tradition*. 1997. http://xroads.virginia.edu/~UG97/quilt/atrads.html (8 July 1999).

Norman, Jane. *Religious Beliefs Made Visual: Geometry and Islam*. http://www.askasia.org/frclasrm/lessplan/1000030.htm (8 July 1999).

Crafty Mathematician

Making Art through Mathematics

Introduction

"Mathematics is of little use in everyday life." This common myth is one of the greatest challenges to learning mathematics. The following fun activities can help young people overcome this notion. Participants will learn firsthand that mathematics is important in art. They will use geometry and measurement skills to make traditional crafts.

This project guide is somewhat different from the other four guides in the series. The others focus on particular themes; this guide uses crafts to teach mathematics. You may want to use crafts that reflect a particular holiday or season. Clubs, museums, and after-school programs may want to do this project as a unit. In a classroom, try the activities separately to build learner skills or to support the existing curriculum.

Cautions

This project is not a standards-based math curriculum. While many of the activities support such curricula, this unit is not a systemic approach to teaching mathematics.

Community Connections

People in all societies create and enjoy arts and crafts. Most societies establish ceremonies involving forms of decoration and gift-giving to recognize special events, seasons, holidays, relationships, and passages. Young people who develop the skills to create decorations and gifts can take a more active part in these ceremonies. They also learn to appreciate the skill and creativity required to produce seemingly simple designs. And they learn that mathematical skills and concepts are central to many craft activities. Making crafts is an enjoyable way for young people to exhibit their learning.

This project provides an opportunity to introduce your group to local crafters—your community's "informal mathematicians." Invite crafters to demonstrate simple craft activities to your group. Take a field trip to craft stores or a craft show. Your group may even want to put on its own craft show and sell crafts to make money for a good cause. Be ready to highlight the mathematics your group has used in producing its crafts.

Activities: Brief Descriptions

Activity 1: It's All a Plot! Get the big picture of using coordinates to locate a region—and end up with a pretty picture.

Activity 2: The Plot Deepens—Coordinate Ornaments. Use coordinates to make art. Celebrate a holiday using math.

Activity 3: 3-D Geometry—Space Out! What happens when your world is transformed from two dimensions to three? Explore the process with some geometric patterns.

Activity 4: Reflections of My World—Building a Kaleidoscope. Everyone loves kaleidoscopes. Build your own, and discover the wonderful world of reflection.

Activity 5: When You Wish Upon a Star—Geometric Line Ornaments. You won't tie yourself in knots in this string activity; you will just make a pretty ornament.

Activity 6: Something's Squirrely Here—Ribbon Pinecones? How can you turn an egg into a pinecone? It doesn't take magic, just ribbon, patience, and math.

Activity 7: Wrap It Up!—Gift Boxes from Greeting Cards. "When you care enough to recycle"—use mathematics to turn greeting cards into expressive boxes.

Activity 8: Making Life Beautiful—Talking with Crafters, Studying Local Crafts. Just why do people make crafts? Use your listening and research skills to explore the role of crafts in your community.

Why Study Mathematics through Crafts?

Benefits to Learners

Topics and concepts. Craft activities are fun ways to reinforce a number of important mathematical skills and concepts. In this activity, learners engage in a number of mathematical activities including these:

- using *x,y* coordinates
- reading and interpreting graphs and charts
- identifying patterns
- making linear measurements
- understanding three-dimensional objects
- applying geometric concepts
- using properties of geometric figures

Skills. While developing artistic expression through mathematics, learners also hone their fine motor skills and artistic awareness. They improve their spatial skills, visualization skills, and direction-following skills through these and other craft-based activities.

Career links. Crafting is a big business. There are thousands of craft-related careers. Among these are making and selling crafts and supplies and designing craft activities. When local crafters visit your group, invite learners to ask questions about craft careers. Crafting activities can help develop graphic design skills, including those needed for World Wide Web design. The same is true for Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) skills. Encourage learners to investigate these career areas, as well as professions in commercial art.

Compliance with national mathematics standards. This project addresses the following National Council of Teachers of Mathematics (NCTM) middle school mathematics content standards:

Geometry

- identify, describe, compare, and classify geometric figures
- visualize and represent geometric figures with special attention to developing spatial sense
- explore transformations of geometric figures
- develop an appreciation of geometry as a means of describing the physical world

Measurement

- cultivate an understanding of the process of measurement
- estimate, make, and use measurements to describe and compare phenomena
- select appropriate units and tools to measure the degree of accuracy required in a particular situation
- develop an understanding of the concepts of perimeter, area, volume, and angle measure

Benefits to the Community

This project can benefit the community as well as learners. As learners come to see the mathematical knowledge that exists in their community, they will better appreciate their fellow neighbors, particularly older people. Learners will relate to community history and appreciate the knowledge various cultures bring to community life. Learners will also better understand the community's formal and informal economies, including the roles of paid and unpaid labor. They can contribute to a community cause by making and selling crafts. At the same time, they can make others aware of the role crafters play in the community.

Ideas for Additional Projects

There are many possibilities for further study. Explore the role of crafts in art and daily life in various cultures, times, and places. Study the economic impact of crafting on your community—or in various communities around the globe. Learn to make a variety of crafts; study the mathematics, science, and technology that goes into producing them. Explore the environmental impact of various crafts. Put together a crafts book with mathematical activities for younger learners. Try out these activities with a younger group, and refine your materials. Then, make the materials available to the community by publishing them in a local newspaper, making a community display, or using the Web.

Readings for Young People

Hundreds of good books, Web sites, and instruction packets discuss crafts for young people. Visit your local library or crafts store, or use the Internet to find out what is available locally.

Leader Background Information

All leader materials for this project are included in the individual activity guides.

Some activities in this project have handouts that are best reproduced on card stock. Some feature two-sided handouts, which should be copied on the front and back of the same sheet of card stock. If you do not have access to a copier that can "duplex," you can duplicate the front of the handout and then run the copies through again to duplicate the back. Activity instructions recommend making handouts for each learner, but handouts could be made for each table or small group of learners.

Safety Note:

Some activities require fine motor skills and the use of sharp objects (pins and scissors). Make sure the activities are age appropriate for your learners, or adapt the activities accordingly.

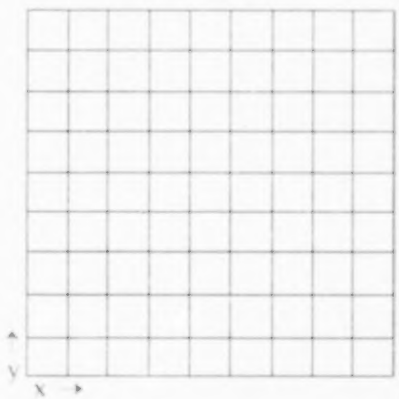
Activity 1

It's All a Plot!

Leader Notes

This activity consists of plotting regions on a grid using coordinates. It is simple to do and can be used with younger learners or learners whose fine motor skills are not well developed. The ability to use coordinates is important to mathematics and science, as well as to map reading and crafts. Learners should discover that working with coordinates is useful not only for mathematicians, artists, and craftspeople, but also for themselves.

Learners use a grid and coordinates to construct a picture. Through this process, they make connections between the coordinates (x,y) and areas on a grid. The x represents the horizontal direction of the grid; the y represents the vertical direction.



Seeing their pictures develop will help learners better understand the plotting system. This allows them to be aware of their own achievements. Completed pictures should be decorated and displayed. Simple directions for this activity are included in Handout 1-1

Materials Checklist

- ☐ Handout 1-1 (1 per learner)
- ☐ Package of coded picture pieces, cut from either Handout 1-2 or your own picture (1 per learner) (Note: Handout 1-2 is copied front and back.)
- ☐ Handout 1-3—puzzle grid (1 per learner)
- ☐ Glue (1 bottle or stick per 4 learners)
- ☐ Colored pencils or crayons (1 set per 4 learners)
- ☐ Handout 1-4 (if learners create their own pictures or if you provide pictures) (Note: Handout 1-4 is two sided.)
- ☐ Picture sources—old magazines, catalogues, or coloring books

Approximate Time Required

Plot picture provided, 15 minutes

Create your own picture plot, 30 minutes

Environmental Note

Recycle leftover paper

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy handouts.
- ☐ Gather materials.

Key Questions

- What are (*x*,*y*) coordinates? How can they be used to locate a region?

A sample picture is included as Handout 1-2. Note that Handout 1-2 is meant to be copied front and back. Make enough two-sided copies for each member of the group. Cut each one along the lines on the back into one-cell blocks. Place each set of the blocks of the picture into a resealable plastic bag or envelope. Give each learner a set of the cells of the picture, Handout 1-3, a glue stick, and colored pencils or crayons.

This activity can be more meaningful if you use pictures relevant to an event, your group, or a season. If learners are creating their own pictures, provide each with a copy of Handout 1-4. Be sure to copy it front and back! They will also need a source of pictures: old magazines, catalogues, coloring books, etc. After learners have glued their pictures to the side that says "Place your picture here," they should cut along the grid lines on the back and give their picture pieces to another member of the group.

Explain to the learners that the purpose of this activity is to create a picture by understanding the coordinates (*x*, *y*). Each learner will have a set of squares with pictures on the front and number pairs (coordinates) on the back. The first number in each pair represents the horizontal location of the piece; the second number represents the vertical location. For example, (4,5) would be located four units to the right of zero and five units above zero. The coordinates serve as the directions for assembling the puzzle. Once they have correctly placed all puzzle pieces on the grid, they can glue them in place and decorate the picture with colored pencils or crayons.

Activity 2

The Plot Deepens—Coordinate Ornaments

Leader Notes

This activity gives learners additional practice in using coordinates. Learners create a decorative ornament by coloring squares on a coordinate grid and decorating the result.

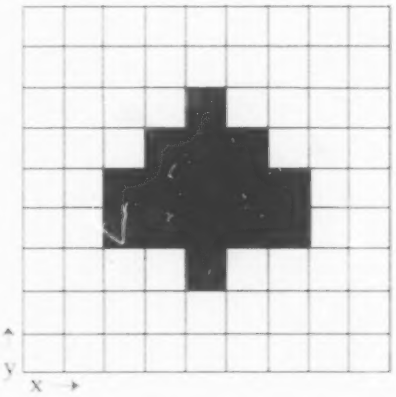
Coordinates for three sample pictures—a tree, a pumpkin, and a wreath—are included. You may prefer to develop your own picture to reflect your group, a special occasion, or a season. An extension of this activity is to ask learners to design their own pictures, develop coordinates from their designs, and produce directions for others to make ornaments.

Key Questions

- What are (x,y) coordinates? How can they be used to locate a region on a grid?

Give each participant a set of directions (Handout 2-1) and a copy of the grid (Handout 2-2).

Select among the lists of coordinates (Handout 2-3 for the tree, handout 2-4 for the wreath, Handout 2-5 for the pumpkin, or a list of coordinates for your own design); provide copies of the appropriate set for each learner. Each learner should also receive an 8" x 10" piece of black construction paper, a



Materials Checklist

- ☐ Handout 2-1 (1 per learner)
- ☐ Handout 2-2—grid (1 per learner)
- ☐ List of coordinates (Handouts 2-3, 2-4, 2-5, or your own)
- ☐ Colored markers, pencils, or crayons
- ☐ Scissors (1 pair per 4 learners)
- ☐ Glue (1 bottle per 4 learners)
- ☐ Glitter
- ☐ Black felt-tip markers (1 per 4 learners)
- ☐ Colored construction paper (6"x 8") (1 per learner)
- ☐ Black construction paper (approximately 8"x 10") (1 per learner)
- ☐ White paper (approximately 7"x 9") (1 per learner)
- ☐ Compasses (1 per 4 learners)
- ☐ 6" ribbons (1 per learner)

Approximate Time Required

30 minutes

Environmental Note

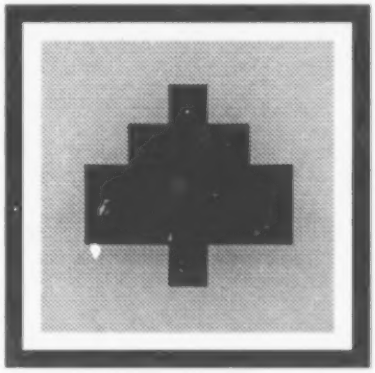
Recycle leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Select the ornament(s) your group will make from the three provided.
- ☐ Copy Handouts 2-1 and 2-2.
- ☐ Copy appropriate Handouts 2-3 to 2-5.

6" x 8" piece of colored construction paper, and a 7" x 9" piece of white paper. Older learners should measure and cut their own paper.

Explain that the coordinate list serves as a set of directions for making a picture. The learner should shade each grid box or cell in the appropriate color as directed by the coordinate list. After the shading is complete, they should outline the picture with a black marker or dark colored pencil. This outline will serve as a guide for cutting out the picture.



After the picture has been cut out, it can be sprayed with glitter. The edges of the white sheet of paper can also be sprayed with glitter. Glue the picture to the square of colored construction paper. Glue this square to the white glitter paper. Glue this square to the black paper. When finished, the picture will appear to be in a three-colored frame.

Next, punch a hole in the top of the black paper. Thread a ribbon through the hole, and tie the ribbon together to form a loop. The picture ornament is now ready to be hung.

Making Your Own Design

It is simple to make your own design. Place a sheet of grid paper over the picture or symbol you have chosen. Trace the picture onto the grid paper. Color the squares of the picture the appropriate colors, then develop a list of coordinates such as those found in Handouts 2-3, 2-4, and 2-5.

Activity 3

3-D Geometry—Space Out!

Leader Notes

Learners will explore the distinguishing features of solids (the third dimension or depth) by transforming two-dimensional patterns into three-dimensional geometric figures. They can decorate their three-dimensional objects to serve as ornaments.

Key Questions

- What is a three-dimensional object?
- What are some ways that two-dimensional and three-dimensional objects can be related?
- Most learners have already experienced measuring length and width. Remind them of the measurement process by having them measure a piece of paper. If measuring a box, remind them also to measure depth.

In this activity, learners will make three-dimensional objects out of two-dimensional patterns. Handout 3-1 provides directions for the activity.

Handouts 3-2 to 3-8 are templates for the geometric figures. You will need to copy the templates onto heavy paper or card stock.

Learners should identify the edges, faces, and vertices of each figure. Handout 3-9 (optional) is a table for them to record this information (see answer key, next page).

Materials Checklist

- ☐ Handout 3-1 (1 per learner)
- ☐ Handouts 3-2 through 3-8 (1 per learner) (Note: These should be copied on card stock.)
- ☐ Handout 3-9 (optional, 1 per learner)
- ☐ Scissors (1 per 4 learners)
- ☐ Glue or rubber cement (1 bottle per 4 learners)
- ☐ Fishing line (1 10" piece per learner)
- ☐ Compasses (1 per 4 learners)
- ☐ Glitter, stickers, paint, or other decorations

Approximate Time Required

15 minutes per figure

Environmental Note

Recycle leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Select figures to be used.
- ☐ Copy handouts.
- ☐ Gather materials.

Three-Dimensional Solids (Handout 3-9 answer key)

Handout	Name	Edges	Faces	Vertices
3-2	Pentagonal Prism	15	7	10
3-3	Tetrahedron	6	4	4
3-4	Pyramid	8	5	5
3-5	Prism	9	5	6
3-6	Octahedron	12	8	6
3-7	Icosahedron	30	20	12
3-8	Rhombohedron	12	6	8

The completed three-dimensional figures can be decorated for any occasion. As part of an astronomy exhibit, they could be brightly colored with flourescent paint. They could be painted the colors of your school or organization. The flexibility of these basic patterns allows them to be used in many different ways. Ask your group for suggestions on how they would like to decorate and use their own creations.

BEST COPY AVAILABLE

Activity 4

Reflections of My World—Building a Kaleidoscope

Leader Notes

This activity explores geometric concepts of *reflection* and symmetry. The finished product—a kaleidoscope—allows learners to see symmetric patterns formed by reflecting images off a shiny surface.

Key Question

- What is reflection?

For the shiny surface, use reflective foil tissue paper or Mylar from an old Mylar balloon. Foil tissue paper is sold in most gift, card, craft, or grocery stores. Use spray-on glue, sold in craft stores, to attach the paper or Mylar to a cardboard backing. Make sure to use the spray glue in a well-ventilated area. Then cut the foil-backed cardboard into 1" x 3" strips.

Depending on the age group you are working with and the amount of time set aside for the activity, you may decide to have learners measure their own materials.

Provide each learner with a toilet paper tube. Learners should glue wrapping paper to the outside of the tube. You may want to use wrapping paper that corresponds with a theme, holiday, or time of year. This will form the body of the kaleidoscope. Not all toilet paper tubes are the same size. Measure the tubes you are using to determine the size of the wrapping paper needed. Paper should cover the tube.

Learners tape the long edges of each piece of Mylar-backed cardboard together side by side (see diagram). Fold the three pieces together to form the triangle or prism, with the tape on the *outside* of the prism. The reflective surfaces should be on the inside of the prism.

Materials Checklist

- ☐ Handout 4-1 (1 per learner)
- ☐ Transparent tape (1 roll per 8 learners)
- ☐ Glue (1 bottle per 8 learners)
- ☐ Plastic portion cups with clear lids (1 per learner) (**Note**: Restaurants may sell or donate these, or you can get them at a restaurant supply store.)
- ☐ Clear colored beads of assorted sizes and colors (5-10 per learner)
- ☐ Toilet paper tubes (1 per learner)
- ☐ Wrapping paper (approximately 4-1/2" x 6") (1 piece per learner)
- ☐ Paper towels
- ☐ Reflective Mylar or foil tissue paper (1" x 3") (3 pieces per learner)
- ☐ Thin card stock or cardboard (approximately 1-3/8" x 3") (3 pieces per learner)

Approximate Time Required

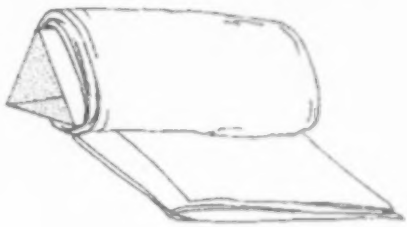
15 minutes

Environmental Note

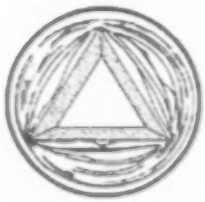
Recycle leftover paper.

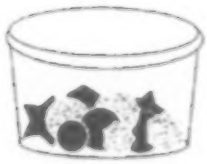
Tape together the remaining two edges.

Fold a paper towel in fourths, and wrap it completely around the prism.



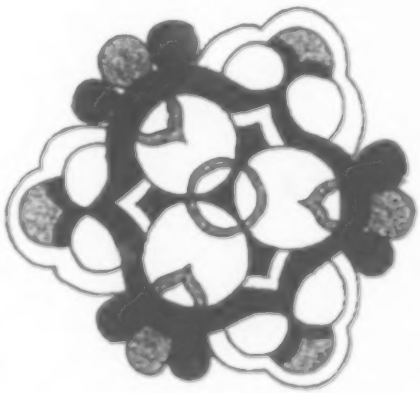
Place the prism and paper towel snugly in the center of the tube. The paper towel should hold the prism in place.





Place the translucent-colored beads in a portion cup. Snap the lid securely on the cup. Put the cup in the end of the toilet paper tube. The lid of the portion cup should rest against the end of the tube. The body of the cup should nestle within the tube. You may need to use tape to secure the cup in the end of the tube.

Point the kaleidoscope toward a light source. As learners rotate the kaleidoscope, they will see various symmetric designs. Try experimenting with different objects and colors of beads in the portion cup.



What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 4-1.
- ☐ Gather materials.
- ☐ Glue Mylar (or foil tissue paper) to card stock.

< Definition

Reflection refers to producing an image by (or as if by) a mirror. When something is reflected, light waves bounce back from the surface.

Safety Note

Use spray glue in a well-ventilated area.

Activity 5

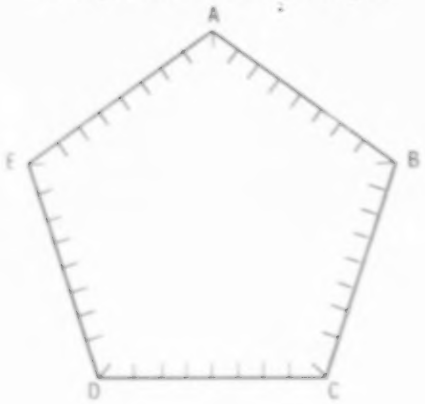
When You Wish Upon a Star—Geometric Line Ornaments

Leader Notes

Learners will create a star-shaped ornament using a pentagon—a five-sided geometric figure. Learners will gain experience working with geometric shapes and using a ruler to measure.

Key Question

- What characteristics of geometric shapes are important in making string art?



It may be useful to have a finished ornament on display.

Give each learner the activity directions (Handout 5-1), the pentagon pattern (Handout 5-2), and a piece of heavy cardboard or mat board.

Gold-colored scraps from picture matting work well. Framing shops might be willing to donate scraps. Have learners trace the pattern on the cardboard and cut the figure out. When working with young children, it may be easier to cut the cardboard in advance. Handout 5-1 has instructions and diagrams illustrating what to do next to complete this ornament.

Materials Checklist

- ☐ Handout 5-1 (1 per learner)
- ☐ Handout 5-2—pentagon pattern (1 per learner)
- ☐ Heavy cardboard or mat board (1 per learner) (Note: Scraps of matting from picture frames work well.)
- ☐ Scissors (1 per learner)
- ☐ String (approximately 9 yards per learner)
- ☐ Rulers (1 per 8 learners)
- ☐ Pencils (1 per 8 learners)

Approximate Time Required

20 minutes

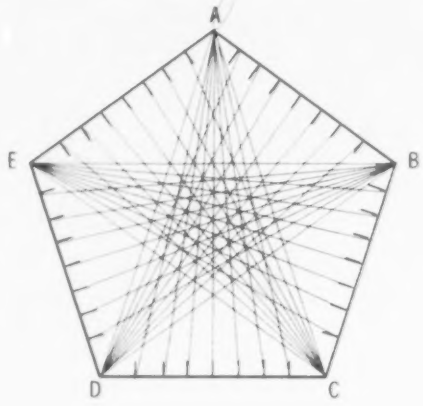
Environmental Note

Recycle leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 5-1.
- ☐ Gather materials.

Extend this activity by having the learners create their own ornament designs using different geometric shapes. The shape must have an odd number of sides and a vertex opposite each side. A triangle is an example of such a shape. Younger learners may need to work with a triangle. Older learners can experiment with different numbers of sides.



Activity 6

Something's Squirrely Here—Ribbon Pinecones?

Leader Notes

This activity brings together geometry, measurement, estimation, and art to make beautiful ornaments. Using an egg-shaped Styrofoam™ base, learners make a pinecone-shaped decoration using ribbon. This decoration can be adapted for any season or occasion based on the choice of ribbon. This activity not only provides learners with a product they can be proud of, it's fun!

Key question

- What is one way you can use geometry to make a decorative object?

Use Handout 6-1 to guide this activity.

All learners will be able to make pinecones; however, a learner's motor skills, as well as measuring ability, will influence an ornament's appearance. Learners must be able to manipulate fairly small pieces of cloth. If some learners in your group have difficulty with this, do the activity in pairs or teams, or provide additional assistance to those who are struggling with motor skill aspects.

Some learners may need assistance getting the first row of ribbon in place and topping off the last row of ribbon.

Ribbon can be expensive; however, craft and fabric stores usually sell out-of-season ribbon at greatly reduced prices. To make this activity more affordable, plan ahead so you can buy out-of-season ribbon (e.g., holiday ribbon in January, autumn ribbon in November, spring ribbon in May).

Use stiff ribbon, at least 1-inch wide, for best results. The ribbon needs to be stiff enough to hold its shape when folded. Do not use ribbon with wire in it. If you use

Materials Needed

- ☐ Handout 6-1 (1 per learner)
- ☐ 3 yards of stiff non-satin ribbon at least 1" wide (1 per learner)
- ☐ Scissors (1 per learner)
- ☐ Straight pins (approximately 50 per learner)
- ☐ Styrofoam™ eggs (1 per learner)
- ☐ Rulers (1 per 8 learners)
- ☐ Glue
- ☐ Felt (1 small piece per learner)
- ☐ 1/4" ribbons (6" per learner)

Approximate Time Required

45 minutes

Environmental Note

Recycle leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 6-1.
- ☐ Gather materials.
- ☐ Make a sample ornament for display.

larger eggs (e.g., goose-egg sized) or narrower ribbon, you will need more than the 3 yards suggested. Try to provide a variety of ribbon colors or patterns so learners may personalize their eggs.

Learners often want to use many more pins than necessary. Point out that they need, at most, two pins per piece of ribbon. Using more than two pins detracts from the appearance of the pinecone.

Have a tape measure and a considerably larger egg on hand for the following mathematical challenges:

- determine how much ribbon you would need for your pinecone if the ribbon were 1.5 inches or 2 inches wide
- *estimate* how much ribbon you would need to make a pinecone with the larger egg
- *calculate* how much ribbon you would need to make the larger pinecone

Activity 7

Wrap It Up!—Gift Boxes from Greeting Cards

Leader Notes

As they create gift boxes from greeting cards, learners practice measuring, following directions, and making estimates. This simple activity illustrates that recycling can be easy—and fun! Learners can use their finished boxes for small gifts. This activity can be done at any time throughout the year; it will be most meaningful if it reflects the theme of a relevant event, season, or holiday.

Key Question

- How can I make a 3-dimensional box from a 2-dimensional piece of cardboard?

Each learner needs a greeting card. Encourage learners to bring old bi-fold cards from home (bi-fold cards open from right to left). Medium and large cards work best because very small cards are difficult to fold. Handout 7-1 will guide learners through this activity.

You may want to have learners calculate the approximate volume of the boxes they have made. Then, challenge them to determine what size card they would need to start with to make boxes of other specific dimensions. For example, if they wanted to make a box big enough to hold a package of chewing gum, how big a card must they start out with? What if they wanted to make a box big enough to hold a button? A baseball?

Materials Needed

- ☐ Handout 7-1 (1 per learner)
- ☐ Greeting cards (1 per learner) *This is a great way to recycle used cards!*
- ☐ Pens (1 per learner)
- ☐ Rulers (1 per 4 learners)
- ☐ Scissors (1 per 4 learners)
- ☐ Tape (1 roll)

Approximate Time Required

15 minutes

Environmental Note

Recycle leftover paper and cardboard.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Copy Handout 7-1.
- ☐ Gather materials.

Activity 8

Making Life Beautiful—Talking with Crafters, Studying Local Crafts

Leader Notes

In an age of mass production, why do people do crafts? Why are traditional skills still important to us? In this activity, learners use their research skills to explore the role of crafts in their community and document old-time knowledge and skills.

Key Question

- Key questions for this activity should come from the learners and arise from learners' dialogues with crafters.

The Foxfire Project (http://www.foxfire.org) is a premiere example of the significant roles young people can play in documenting and preserving history and honoring traditional knowledge. In this activity, young people become researchers, documenting the "who, what, when, where, why, and how" of crafts in their community. They should talk with crafters; document the crafters' practice through written words, recordings, and/or photos; and share their work with others. This sharing can be done via publications, exhibits, Web pages, posters, or other activities.

Learners will need to decide what types of information to collect, how to collect it, how to put it together, and how to share it. Not only will they talk with crafters and record artifacts, they will need to do research to put the craft activities in context.

This activity should end with a celebration involving young people, crafters, and other community members. It should honor the skills of both the crafters and the young people who are preserving their work.

Materials Checklist

- ☐ Crafters
- ☐ Access to library/Internet
- ☐ Other materials vary depending on types of documentation and presentation

Approximate Time Required

Varies depending upon number and types of presentations and documentation and the extent of research done

Environmental Note

Recycle leftover paper.

What to Do in Advance

- ☐ Read activity guide.
- ☐ Arrange connections with local crafters.
- ☐ Arrange for access to library and/or Internet.
- ☐ Work with group to decide how interviews/observations will be documented and presented, then arrange for materials (interview forms, photos, audio or video recording, etc.).

Materials Summary

Activity 1: It's All a Plot!

- ☐ Handout 1-1 (1 per learner)
- ☐ Package of coded picture pieces, cut from either Handout 1-2 or your own picture (1 per learner)
- ☐ Handout 1-3—puzzle grid (1 per learner)
- ☐ Glue (1 bottle or stick per 4 learners)
- ☐ Colored pencils or crayons (1 set per 4 learners)
- ☐ Handout 1-4 (if learners create their own pictures or if you provide pictures) (Note: Handout 1-4 is two sided.)
- ☐ Picture sources—old magazines, catalogues, or coloring books

Activity 2: The Plot Deepens—Coordinate Ornaments

- ☐ Handout 2-1 (1 per learner)
- ☐ Handout 2-2— grid (1 per learner)
- ☐ List of coordinates (Handouts 2-3, 2-4, 2-5, or your own)
- ☐ Colored markers, pencils, or crayons
- ☐ Scissors (1 pair per 4 learners)
- ☐ Glue (1 bottle per 4 learners)
- ☐ Glitter
- ☐ Black felt-tip markers (1 per 4 learners)
- ☐ Colored construction paper (6"x 8") (1 per learner)
- ☐ Black construction paper (approximately 8"x 10") (1 per learner)
- ☐ White paper (approximately 7"x 9") (1 per learner)
- ☐ Compasses (1 per 4 learners)
- ☐ 6" ribbons (1 per learner)

Activity 3: 3-D Geometry—Space Out!

- ☐ Handout 3-1 (1 per learner)
- ☐ Handouts 3-2 through 3-8 (1 per learner) (Note: These should be copied on card stock.)
- ☐ Handout 3-9 (optional, 1 per learner)
- ☐ Scissors (1 per 4 learners)
- ☐ Glue or rubber cement (1 bottle per 4 learners)
- ☐ Fishing line (1 10" piece per learner)
- ☐ Compasses (1 per 4 learners)
- ☐ Glitter, stickers, paint, or other decorations

Activity 4: Reflections of My World—Building a Kaleidoscope

- ☐ Handout 4-1 (1 per learner)
- ☐ Transparent tape (1 roll per 8 learners)
- ☐ Glue (1 bottle per 8 learners)
- ☐ Plastic portion cups with clear lids (1 per learner) (Note: Restaurants may sell or donate these, or you can get them at a restaurant supply store.)
- ☐ Clear colored beads of assorted sizes and colors (5-10 per learner)
- ☐ Toilet paper tubes (1 per learner)
- ☐ Wrapping paper (approximately 4-1/2" x 6") (1 piece per learner)
- ☐ Paper towels
- ☐ Reflective Mylar or foil tissue paper (1" x 3") (3 pieces per learner)
- ☐ Thin card stock or cardboard (approximately 1-3/8" x 3") (3 pieces per learner)

Activity 5: When You Wish Upon a Star—Geometric Line Ornaments

- ☐ Handout 5-1 (1 per learner)
- ☐ Handout 5-2—pentagon pattern (1 per learner)
- ☐ Heavy cardboard or mat board (1 per learner) (Note: Scraps of matting from picture frames work well.)
- ☐ Scissors (1 per learner)
- ☐ String (approximately 9 yards per learner)
- ☐ Rulers (1 per 8 learners)
- ☐ Pencils (1 per 8 learners)

Activity 6: Something's Squirrely Here—Ribbon Pinecones?

- ☐ Handout 6-1 (1 per learner)
- ☐ 3 yards of stiff ribbon at least 1" wide (1 per learner)
- ☐ Scissors (1 per learner)

- ☐ Straight pins (approximately 50 per learner)
- ☐ Styrofoam™ eggs (1 per learner)
- ☐ Rulers (1 per 8 learners)
- ☐ Glue
- ☐ Felt (1 small piece per learner)
- ☐ 1/4" ribbons (6" per learner)

Activity 7: Wrap It Up!—Gift Boxes from Greeting Cards

- ☐ Handout 7-1 (1 per learner)
- ☐ Greeting cards (1 per learner) *A great way to recycle used greeting cards!*
- ☐ Pens (1 per learner)
- ☐ Rulers (1 per 4 learners)
- ☐ Scissors (1 per 4 learners)
- ☐ Tape (1 roll)

Activity 8: Making Life Beautiful—Talking with Crafters, Studying Local Crafts

- ☐ Crafters
- ☐ Access to library/Internet
- ☐ Other materials vary depending on types of documentation and presentation

Resources

Thousands of craft books and plans are available in print and on the Web. However, very few show distinct connections to the mathematics involved in making the crafts. In most cases, you will need to point out the mathematical concepts and skills to the learners. We have listed a few activities here; however, the richest sources of information lie in your community. We encourage you to seek out craft practitioners among your friends, neighbors, and community members.

You may also find craft ideas and make connections with crafters at local craft or hobby stores. These stores often have hundreds of plans available for free or at low cost.

Books

Cook, Shirley. *Math in the Real World of Design and Art: Geometry, Measurements, and Projections.* Nashville: Incentive, 1996.

Lappan, Glenda, James T. Fey, William M. Fitzgerald, Susan N. Friel, and Elizabeth Difanis Phillips. *Filling and Wrapping: Three Dimensional Measurement.* Palo Alto, CA: Dale Seymour, 1997.

Masalaski, William J. *Communicating Mathematics with Geoboards.* Fort Collins, CO: Scott Resources, 1996.

Web Sites

Origami-Models & Diagrams
http://ccwf.cc.utexas.edu/~vbeatty/origami/folding

Snowflakes You Can Make
http://members.surfsouth.com/~rlogue/snowup.htm

Weave a Kwanzaa Mat
http://www.geocities.com/Heartland/Hills/8859/matt.html

Computer Software

Aunt Annie's Crafts for Windows: Boxes and Bags Project List. Dayton, OH: dot.ware, 1998.

Crafty Mathematician

Handout 1-1

Picture Plots

- Get a bag of puzzle pieces and a grid (Handout 1-3).
- Place each piece of the puzzle on the grid according to the coordinate given on the back.
- When you are sure the picture makes sense, glue the pieces down.
- Color the picture any way you please.
- Mount the picture on construction paper.

Crafty Mathematician

Front

Handout 1-2

Instructions to Leader: Copy this handout front and back (one copy for each group member). Then cut the pieces apart along the lines. Shuffle each set of pieces and put sets in separate envelopes or plastic sandwich bags.

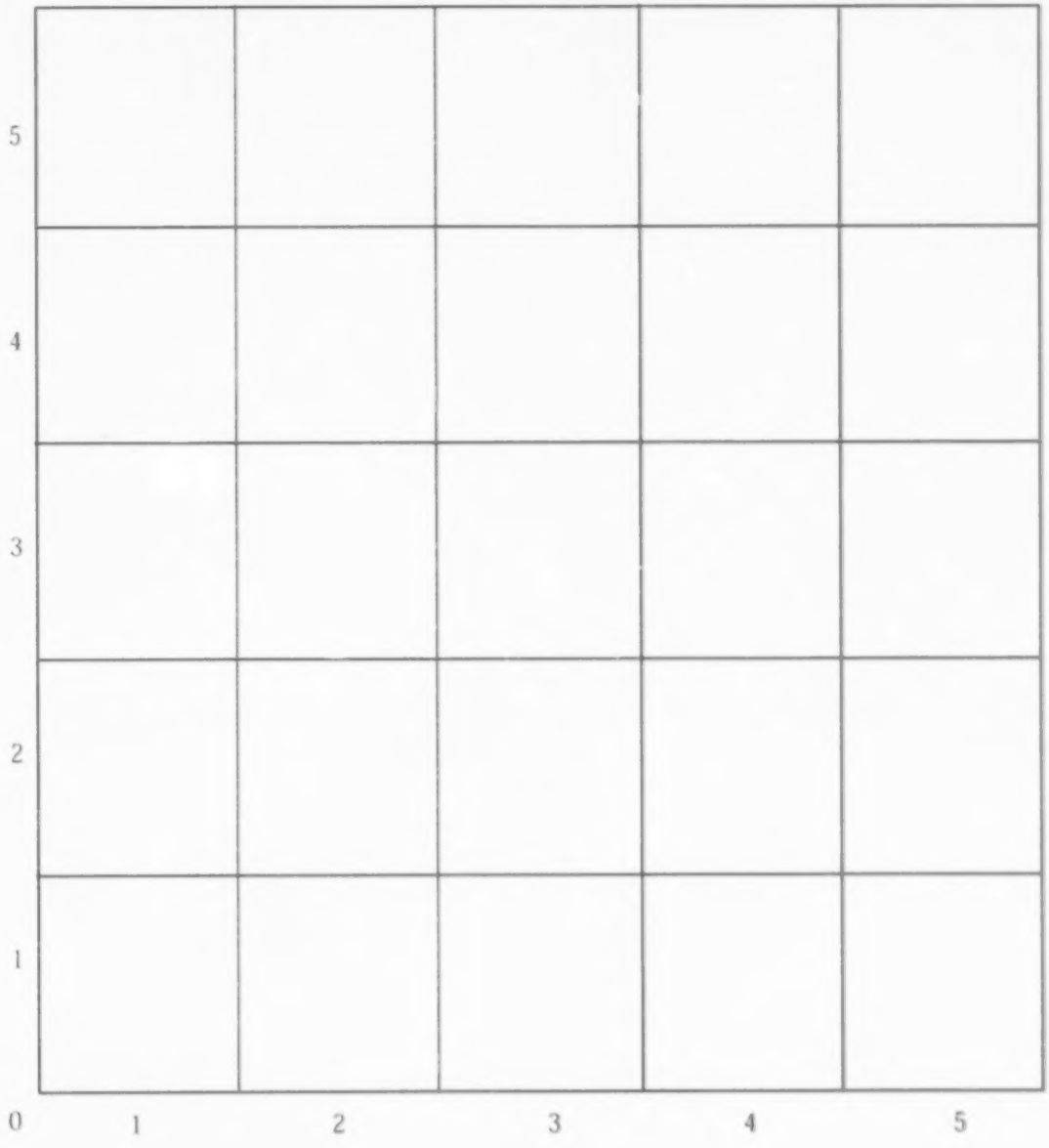
Back of Handout 1-2

Puzzle Template

5,5	5,4	5,3	5,2	5,1
4,5	4,4	4,3	4,2	4,1
3,5	3,4	3,3	3,2	3,1
2,5	2,4	2,3	2,2	2,1
1,5	1,4	1,3	1,2	1,1

Handout 1-3

Puzzle Grid



Crafty Mathematician

Front

Handout 1-4

Side 1

Place Your Picture Here

Back of Handout 1-4

5	5,5	5,4	5,3	5,2	5,1
4	4,5	4,4	4,3	4,2	4,1
3	3,5	3,4	3,3	3,2	3,1
2	2,5	2,4	2,3	2,2	2,1
1	1,5	1,4	1,3	1,2	1,1
	5	4	3	2	1

Crafty Mathematician

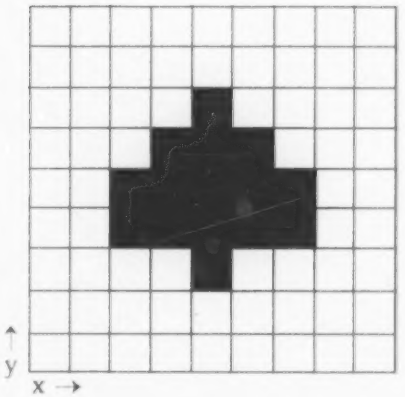
Handout 2-1

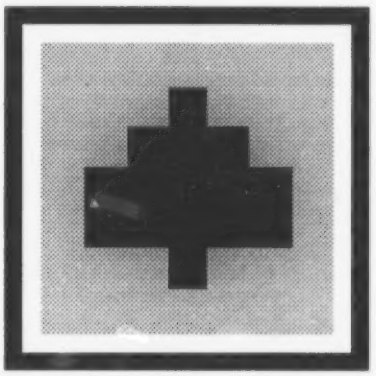
Side 1

X,Y Coordinate Ornaments

Directions:

- Use a crayon or marker to fill in squares according to the list of coordinates.
- Trace the finished picture with black marker or dark colored pencil.
- Cut out the figure along the outline.
- Spray the cut-out picture with glitter. You may also want to spray the white sheet of paper with glitter.
- Glue the picture to the colored construction paper.
- Glue the colored construction paper to the white sheet of paper.
- Glue the white sheet of paper to the black construction paper.
- Add the hanger.

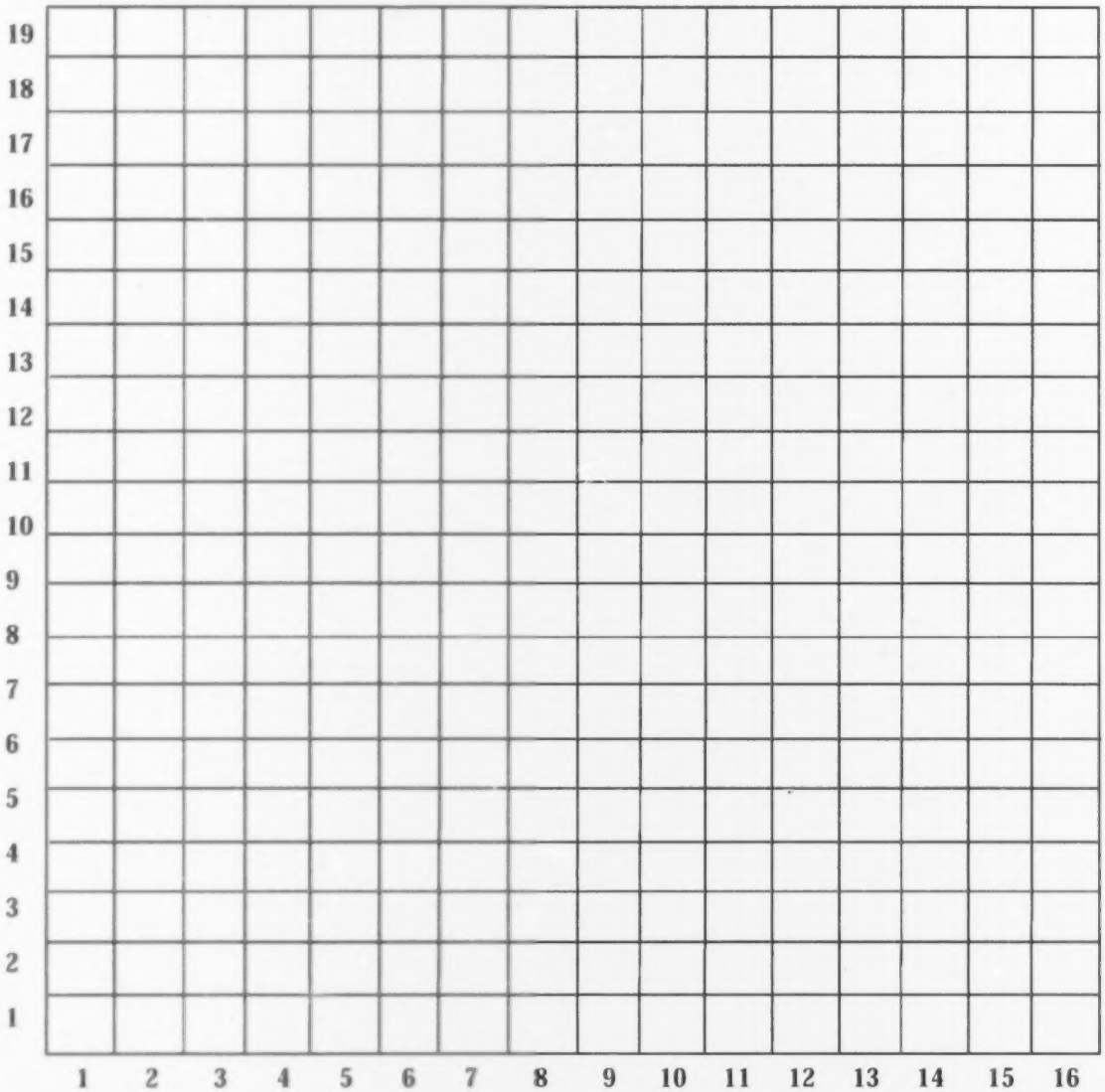




Crafty Mathematician

Handout 2-2

Coordinate Ornaments



Crafty Mathematician

Handout 2-3

Tree Coordinates

Brown	Yellow	Red	Blue	Purple
(7,1)	(6,5)	(2,3)	(7,3)	(5,7)
(8,1)	(4,8)	(3,5)	(5,4)	(8,8)
(9,1)	(16,4)	(7,6)	(10,6)	(9,11)
(10,1)	(14,6)	(6,10)	(14,7)	(9,13)
(7,2)	(12,7)	(8,12)	(12,8)	(10,4)
(8,2)	(7,11)	(10,8)	(13,9)	(12,9)
(9,2)	(10,12)	(11,13)	(10,10)	(13,3)
(10,2)	(8,15)	(12,11)	(6,12)	(13,6)
	(9,15)	(15,4)	(8,13)	(14,5)

Green				
(1, 3)	(7, 4)	(3, 6)	(5, 8)	(9, 10)
(3, 3)	(8, 4)	(4, 6)	(6, 8)	(11, 10)
(4, 3)	(9, 4)	(5, 6)	(7, 8)	(12, 10)
(5, 3)	(11, 4)	(6, 6)	(9, 8)	(13, 10)
(6, 3)	(12, 4)	(8, 6)	(11, 8)	(5, 11)
(8, 3)	(13, 4)	(9, 6)	(13, 8)	(6, 11)
(9, 3)	(14, 4)	(11, 6)	(14, 8)	(8, 11)
(10, 3)	(2, 5)	(12, 6)	(4, 9)	(10, 11)
(11, 3)	(4, 5)	(15, 6)	(5, 9)	(11, 11)
(12, 3)	(5, 5)	(3, 7)	(6, 9)	(7, 12)
(14, 3)	(7, 5)	(4, 7)	(7, 9)	(9, 12)
(15, 3)	(8, 5)	(6, 7)	(8, 9)	(11, 12)
(16, 3)	(9, 5)	(7, 7)	(9, 9)	(6, 13)
(1, 4)	(10, 5)	(8, 7)	(10, 9)	(7, 13)
(2, 4)	(11, 5)	(9, 7)	(11, 9)	(10, 13)
(3, 4)	(12, 5)	(10, 7)	(4, 10)	(7, 14)
(4, 4)	(13, 5)	(11, 7)	(5, 10)	(8, 14)
(6, 4)	(15, 5)	(13, 7)	(7, 10)	(9, 14)
	(2, 6)	(3, 8)	(8, 10)	(10, 14)

Crafty Mathematician

Handout 2-4

Wreath Coordinates

Red			**Yellow**		
(5,1)	(7,5)	(11,3)	(4, 10)	(3,15)	(5,15)
(5,2)	(7,6)	(11,4)	(7, 9)	(4,7)	(5,16)
(5,3)	(7,7)	(11,5)	(9, 9)	(4,8)	(5,17)
(5,7)	(7,8)	(11,6)	(11, 10)	(4,9)	(6,9)
(5,8)	(8,6)	(11,7)	(13, 9)	(4,11)	(6,11)
(6,2)	(8,7)	(11,8)	(14, 11)	(4,12)	(6,12)
(6,3)	(9,6)	(12,1)	(12, 12)	(4,14)	(9,15)
(6,4)	(9,7)	(12,2)	(13, 14)	(5,9)	(6,13)
(6,5)	(10,4)	(12,3)	(10, 17)	(5,10)	(4,15)
(6,6)	(10,5)	(12,6)	(3,12)	(5,11)	(6,17)
(6,7)	(10,6)	(12,7)	(3,13)	(5,12)	(7,13)
(6,8)	(10,7)	(12,8)	(3,14)	(5,13)	(4,16)
(7,4)	(10,8)			(5,14)	
	(11,2)				

Blue	**Green**				
(8,8)	(9,16)	(12,17)	(11,9)	(13,15)	(14,13)
(3,10)	(15,12)	(6,18)	(11,11)	(9,4)	(2,13)
(6,10)		(13,7)	(11,12)	(7,18)	(9,14)
(12,10)	(9,17)	(7,10)	(11,13)	(13,16)	(15,11)
(14,12)	(15,13)	(13,8)	(11,15)	(9,5)	(3,8)
(4,13)	(9,18)	(13,10)	(11,16)	(8,9)	(8,17)
(6,15)	(5,6)	(7,14)	(11,17)	(14,8)	(14,14)
(11,14)	(9,19)	(13,11)	(11,18)	(2,10)	(3,9)
(12,16)	(10,9)	(7,15)	(12,9)	(8,14)	(8,19)
(8,18)	(10,10)	(13,12)	(12,11)	(14,9)	(14,15)
(10,18)	(10,13)	(8,4)	(12,13)	(2,11)	(3,11)
	(10,14)	(7,16)	(12,14)	(8,15)	(9,8)
	(10,15)	(13,13)	(6,14)	(14,10)	(15,10)
	(10,16)	(8,5)	(12,15)	(2,12)	(13,6)
		(7,17)	(6,16)	(8,16)	

Crafty Mathematician

Handout 2-5

Pumpkin Coordinates

Green	**Black**	(5,14)	(7,12)	(9,4)	(10,13)	(12,14)
(8,18)	(3,8)	(6,5)	(7,13)	(9,5)	(11,5)	(13,7)
(8,19)	(4,7)	(6,6)	(8,3)	(9,9)	(11,6)	(13,12)
(9,18)	(4,12)	(6,13)	(8,4)	(9,10)	(11,13)	(13,13)
(9,19)	(4,13)	(6,14)	(8,5)	(10,5)	(11,14)	(14,8)
	(5,5)	(7,5)	(8,9)	(10,6)	(12,5)	
	(5,6)	(7,6)	(8,10)	(10,9)	(12,6)	
	(5,13)	(7,9)	(9,3)	(10,12)	(12,13)	
Orange	(4,3)	(6,4)	(8,6)	(10,2)	(11,17)	(14,4)
(1,7)	(4,4)	(6,7)	(8,7)	(10,3)	(12,2)	(14,5)
(1,8)	(4,5)	(6,8)	(8,8)	(10,4)	(12,3)	(14,6)
(1,9)	(4,6)	(6,9)	(8,11)	(10,7)	(12,4)	(14,7)
(1,10)	(4,8)	(6,10)	(8,12)	(10,8)	(12,7)	(14,9)
(1,11)	(4,9)	(6,11)	(8,13)	(10,10)	(12,8)	(14,10)
(2,6)	(4,10)	(6,12)	(8,14)	(10,11)	(12,9)	(14,11)
(2,7)	(4,11)	(6,15)	(8,15)	(10,14)	(12,10)	(14,12)
(2,8)	(4,14)	(6,16)	(8,16)	(10,15)	(12,11)	(14,13)
(2,9)	(4,15)	(7,1)	(8,17)	(10,16)	(12,12)	(15,6)
(2,10)	(5,2)	(7,2)	(9,1)	(10,17)	(12,15)	(15,7)
(2,11)	(5,3)	(7,3)	(9,2)	(11,1)	(12,16)	(15,8)
(2,12)	(5,4)	(7,4)	(9,6)	(11,2)	(13,4)	(15,9)
(3,3)	(5,7)	(7,7)	(9,7)	(11,3)	(13,3)	(15,10)
(3,4)	(5,8)	(7,8)	(9,8)	(11,4)	(13,5)	(15,11)
(3,5)	(5,9)	(7,10)	(9,11)	(11,7)	(13,6)	(15,12)
(3,6)	(5,10)	(7,11)	(9,12)	(11,8)	(13,8)	(16,8)
(3,7)	(5,11)	(7,14)	(9,13)	(11,9)	(13,9)	(16,9)
(3,9)	(5,12)	(7,15)	(9,14)	(11,10)	(13,10)	(16,10)
(3,10)	(5,15)	(7,16)	(9,15)	(11,11)	(13,11)	(16,11)
(3,11)	(5,16)	(7,17)	(9,16)	(11,12)	(13,14)	(16,7)
(3,12)	(6,2)	(8,1)	(9,17)	(11,15)	(13,15)	
(3,13)	(6,3)	(8,2)	(10,1)	(11,16)	(14,3)	

Crafty Mathematician

Handout 3-1

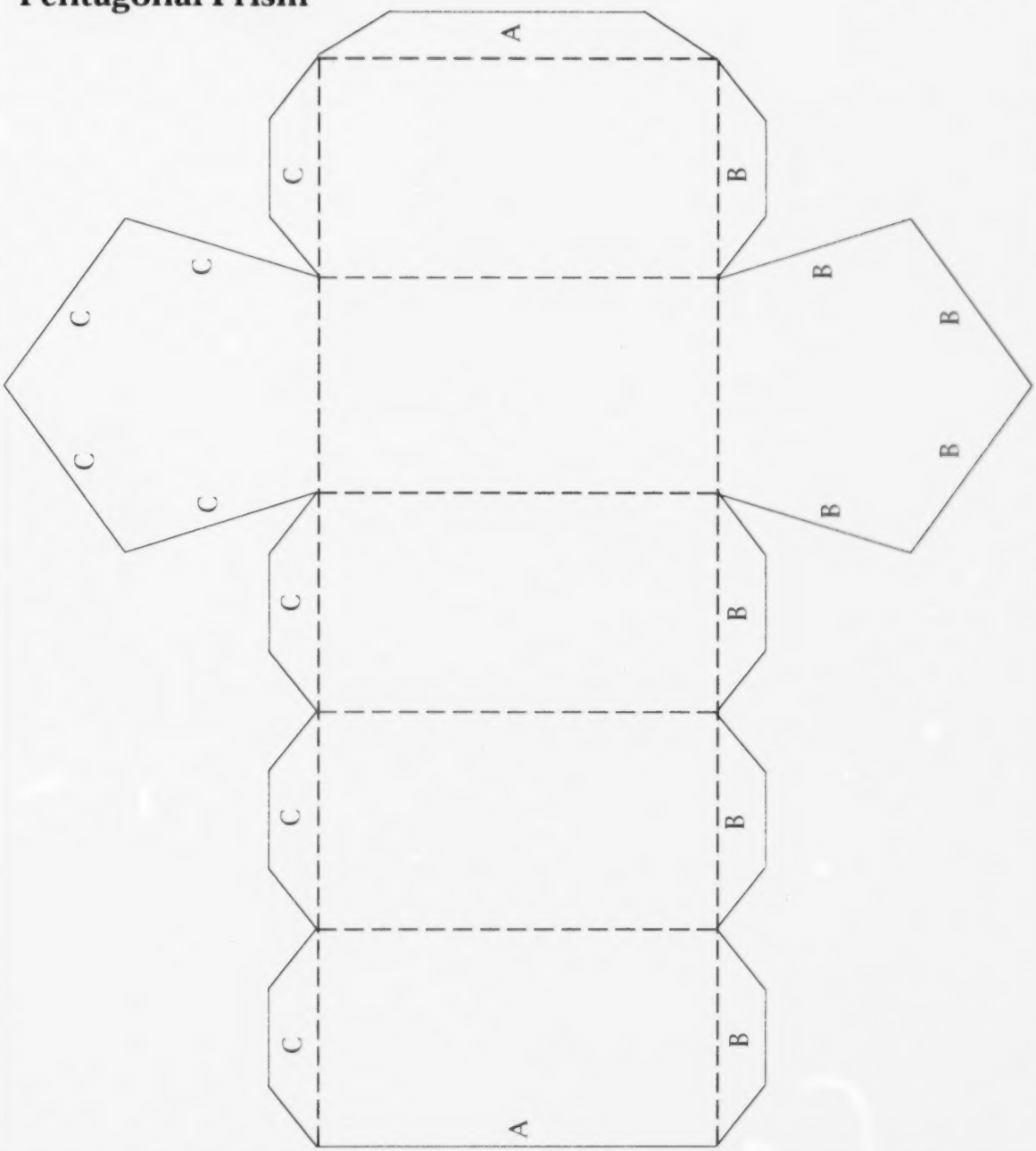
3-D Geometry

- Cut out the construction paper pattern along the solid lines. Be sure not to cut on the dotted lines.
- Fold all tabs backwards on dotted lines. You may want to use the edge of a ruler to guide you in making straight, sharp folds.
- Glue the tabs underneath the matching letters before beginning to fold. This takes some patience. It may be difficult to make the tabs stick.
- Use the sharp point of the compass to put a hole through the top.
- Cut a 10-inch piece of fishing line. Put the line through the hole. Form a loop with the string to make a hanger.
- Decorate your construction with the materials provided.

Crafty Mathematician

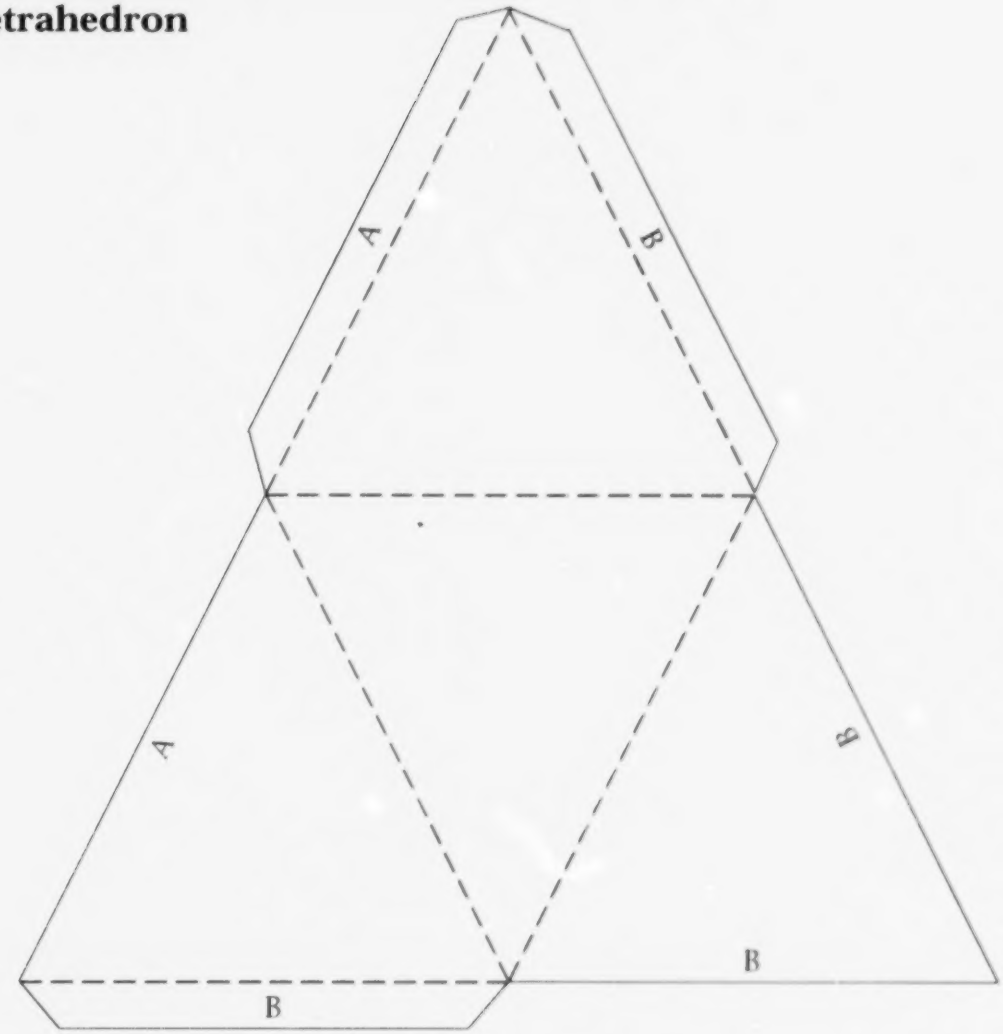
Handout 3-2

Pentagonal Prism



Handout 3-3

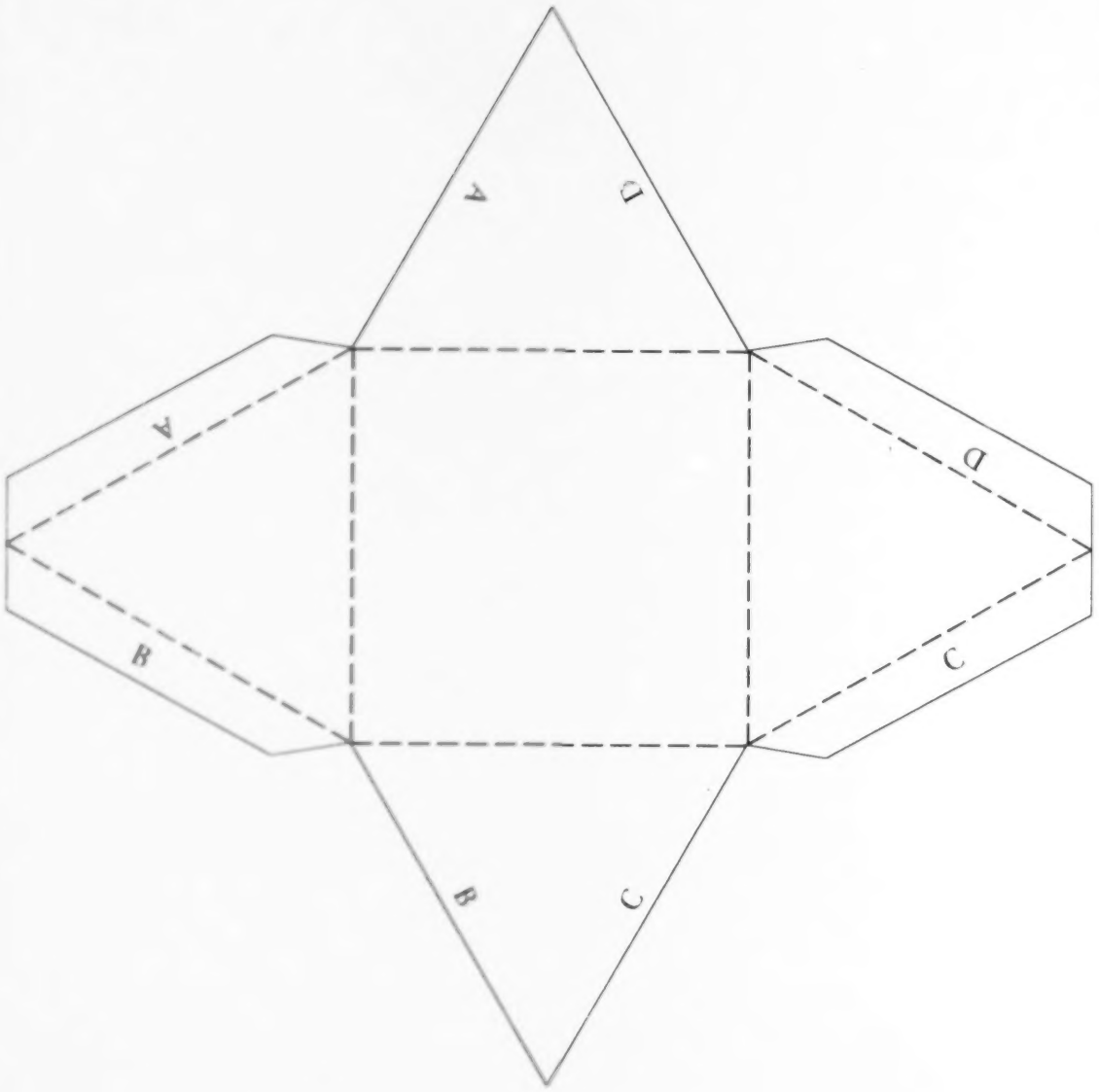
Tetrahedron



Crafty Mathematician

Handout 3-4

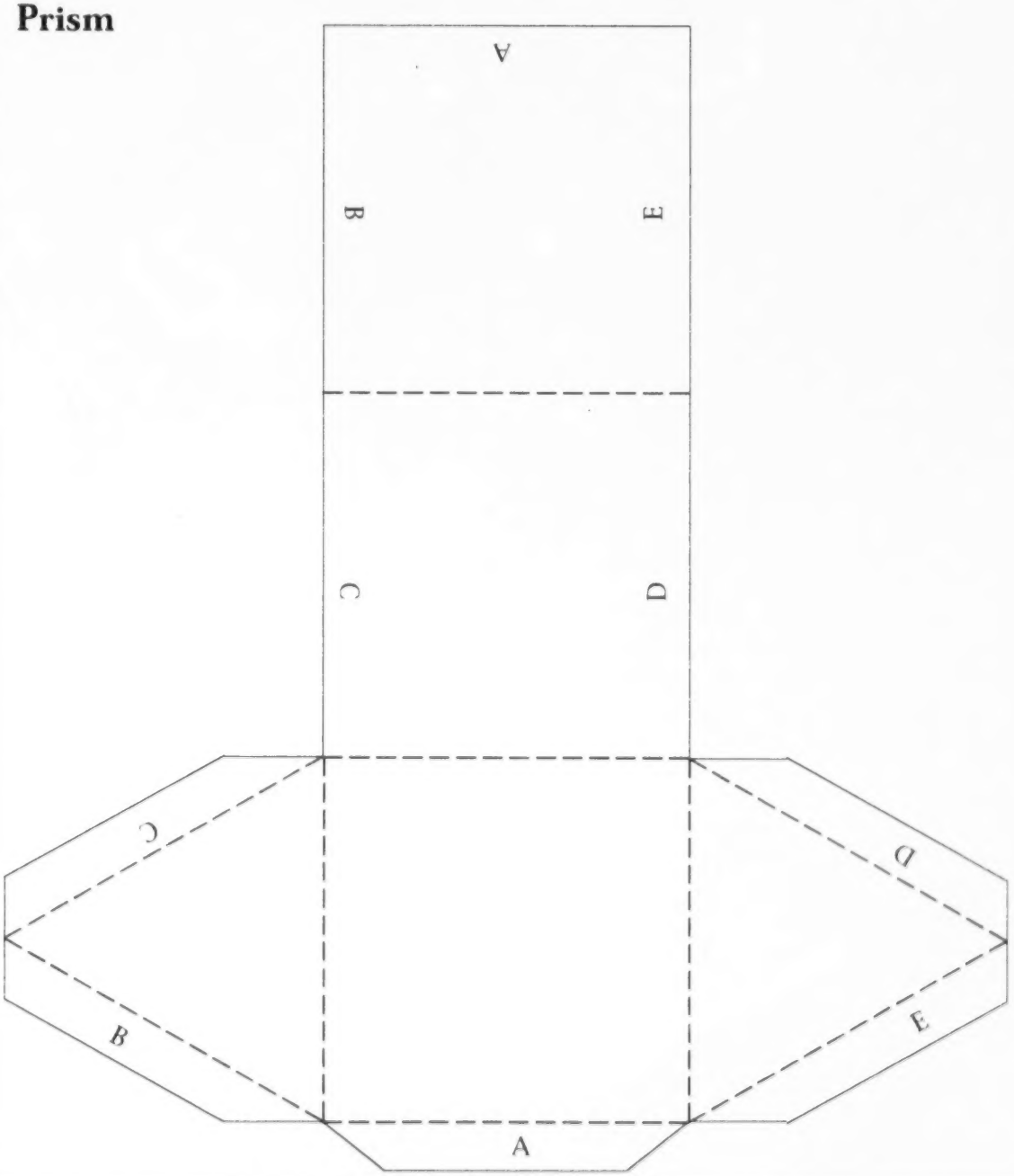
Pyramid



Crafty Mathematician

Handout 3-5

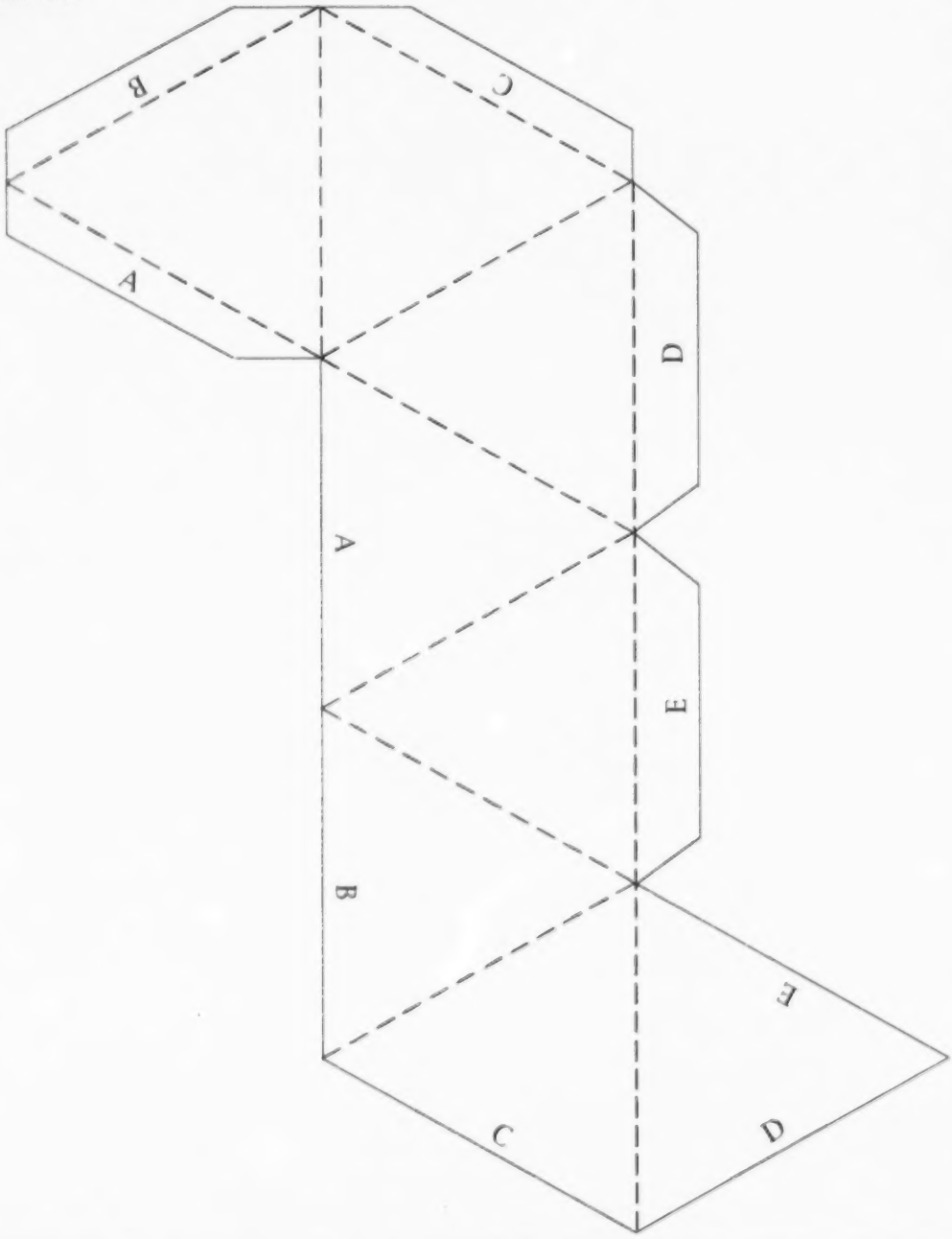
Prism



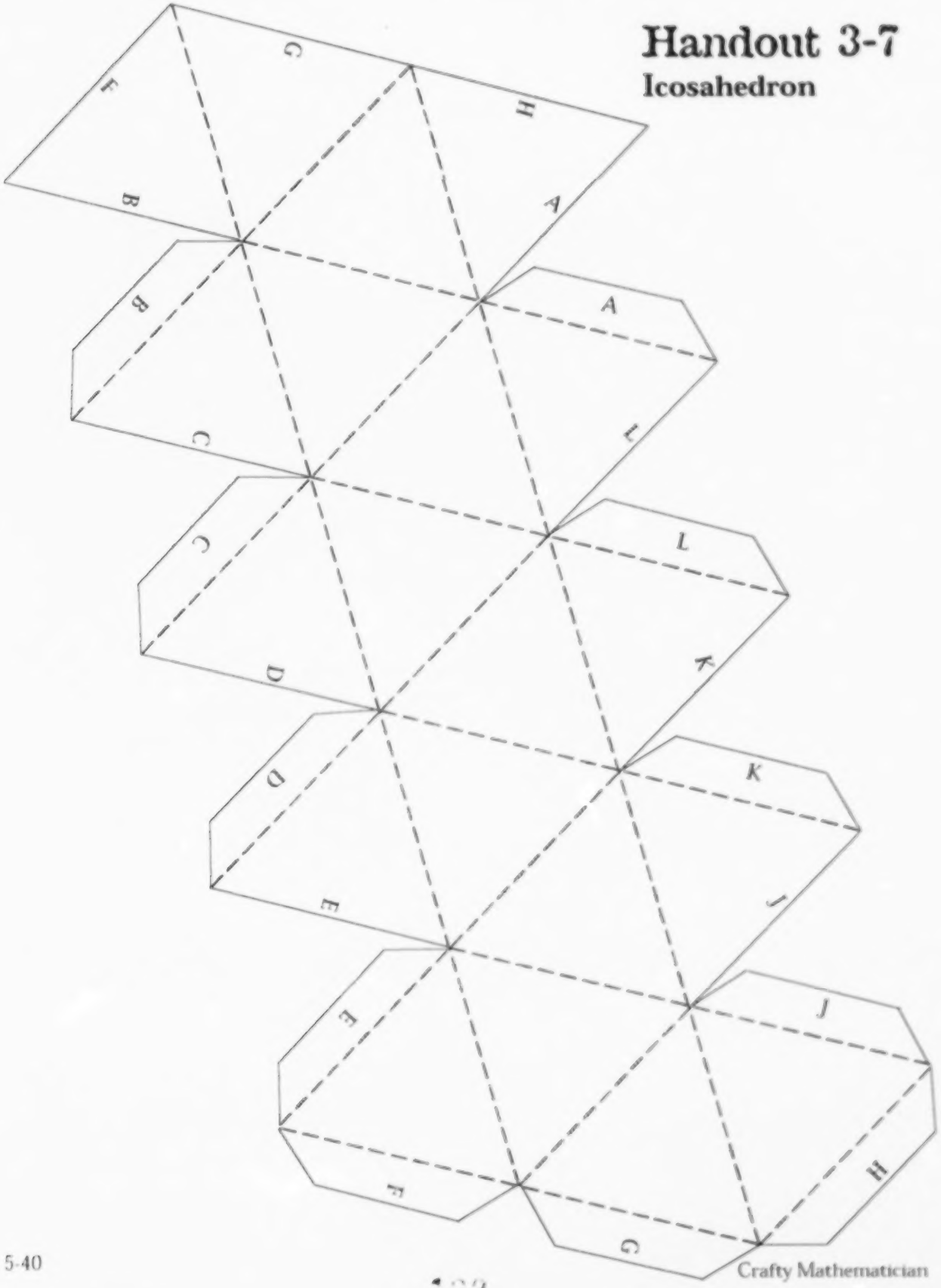
Crafty Mathematician

Handout 3-6

Octahedron



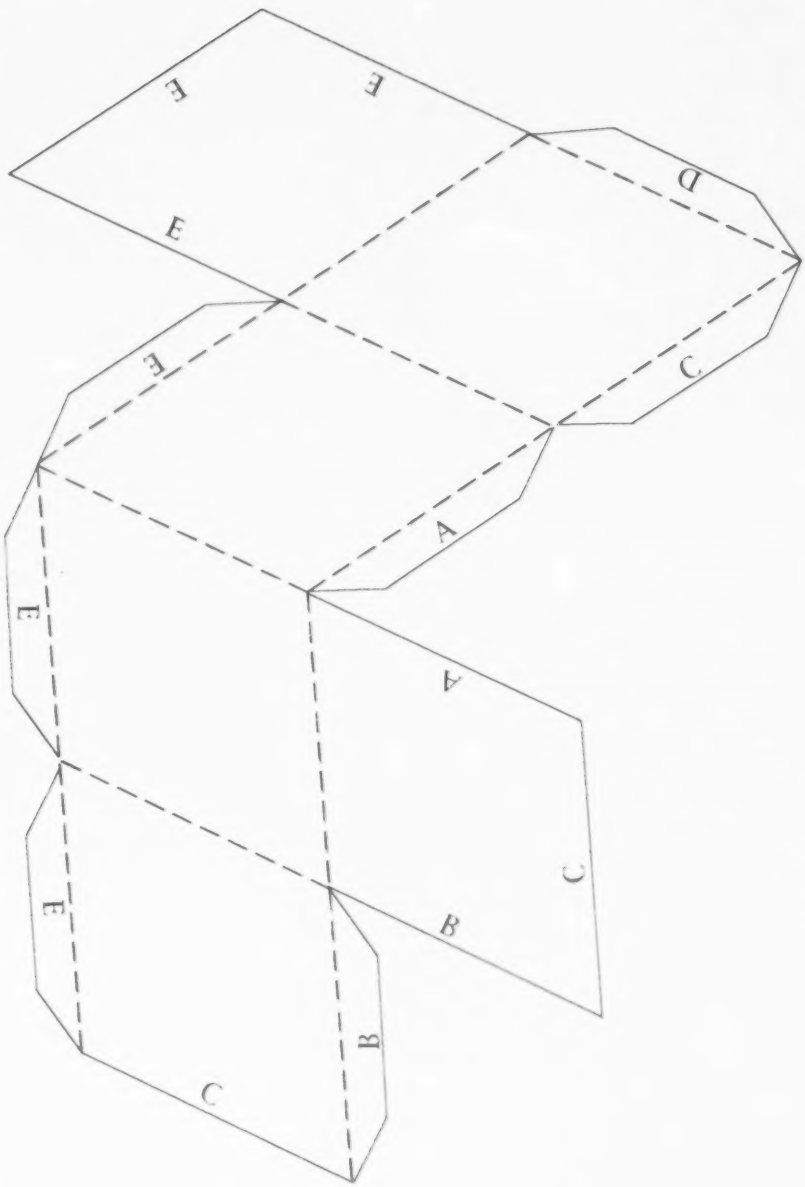
Handout 3-7
Icosahedron



Crafty Mathematician

Handout 3-8

Rhombohedron



Handout 3-9

Three-Dimensional Solids

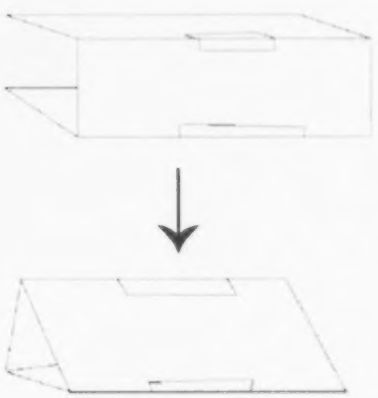
Handout	Name	Edges	Faces	Vertices
3-2				
3-3				
3-4				
3-5				
3-6				
3-7				
3-8				

Crafty Mathematician

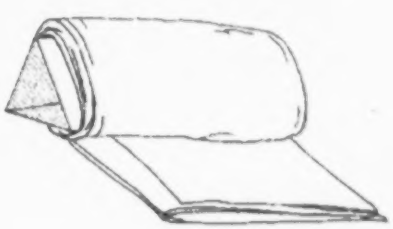
Handout 4-1

Kaleidoscope

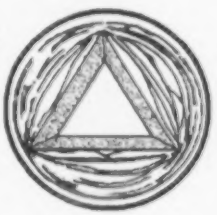
- Measure and cut wrapping paper to fit your toilet paper tube.
- Decorate the outside of the tube by wrapping the paper around the tube and gluing or taping it.
- If your mirrored card stock has not been precut, cut 3 rectangular pieces. Each piece should be 3 inches long and 1 inch wide.
- Join the 3 pieces of mirrored cardboard to form a triangular prism. Use transparent tape along the edges to secure the cardboard. The shiny side must be inside the prism.



- Fold a paper towel in fourths. Then, wrap it completely around the prism.

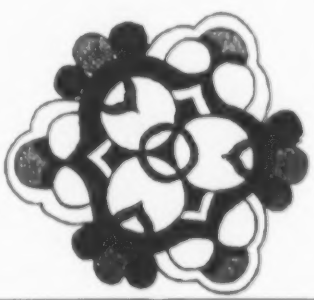


- Trim the paper towel to make sure it fits within the tube.
- Place the prism and paper towel snugly in the center of the tube.



- Place 5 to 10 colored beads in the portion cup, and place the lid on tightly.
- Position the portion cup in one end of the toilet paper tube. The lid of the cup should nestle against the rim of the tube.
- Point the tube toward a light source, and rotate the tube.

Experiment with putting different objects in the cup.



BEST COPY AVAILABLE

Crafty Mathematician

Handout 5-1

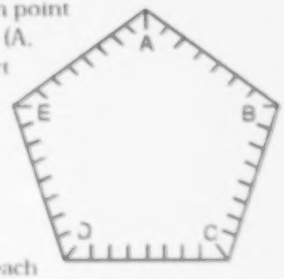
Geometric Line Ornaments

Directions:

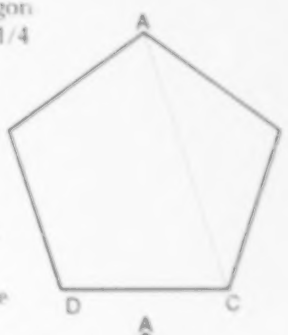
- Trace and cut a pentagon out of the heavy, finished cardboard.

- Cut 9 yards of string.

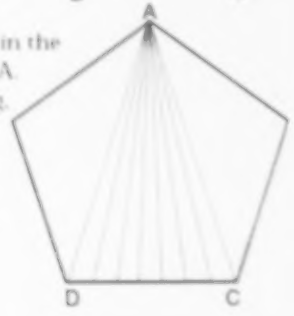
- On the back of each pentagon, mark each point (vertex) with a letter (A, B, C, D, and E). Start with A, and go clockwise around the figure.



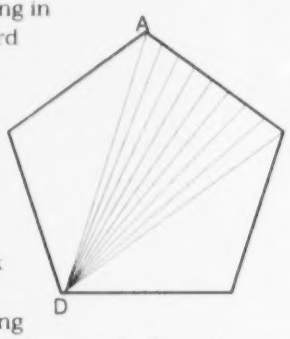
- Cut 1/4-inch-deep notches starting at each corner of the pentagon. Notches should be 1/4 inch apart.



- Place an end of the 9-yard string in notch A; glue the end in place on the backside of the pentagon. Wrap the string to vertex C, securing the string in the notch. Go back to A. Continue wrapping, moving into each notch while going toward D. Stop when you reach D.



- Starting with vertex D, wrap the string to vertex A, back to vertex D, and continue wrapping the string in the notches toward vertex B. Stop when you reach vertex B.



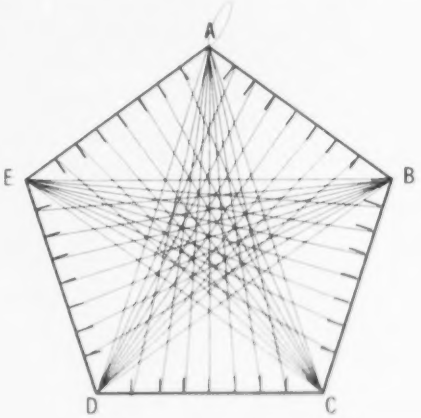
- Starting with vertex B, wrap the string to vertex D. Go back to vertex B. Continue wrapping from vertex B toward vertex E. Stop when you reach vertex E.

- Starting with vertex E, wrap the string to B. Go back to E. Continue wrapping from E toward C. Stop when you reach C.

- Starting with vertex C, wrap the string to E. Go back to C. Continue wrapping toward A.

- Make a 6-inch hanger with string.

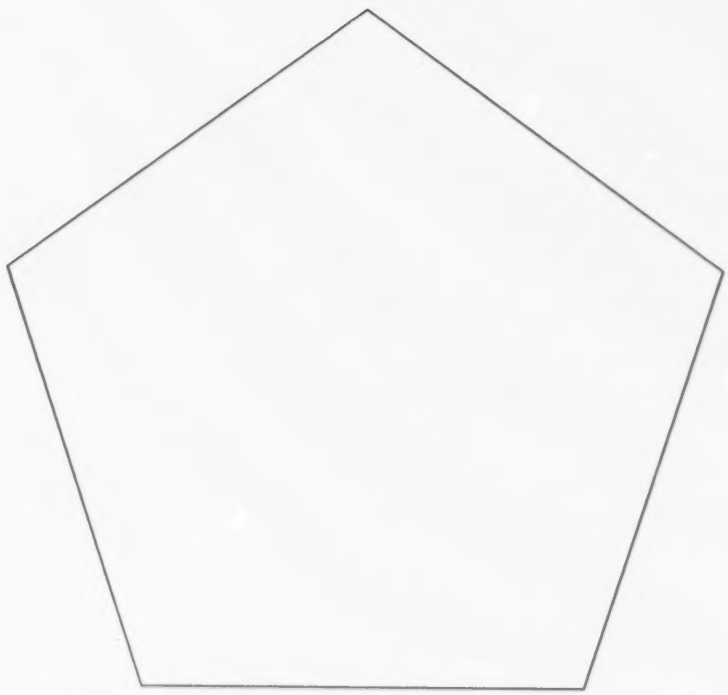
- Secure the hanger with a drop of glue.



Crafty Mathematician

Handout 5-2

Pentagon Template



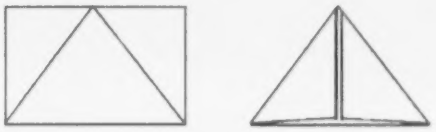
BEST COPY AVAILABLE

Crafty Mathematician

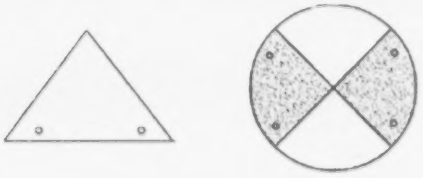
Handout 6-1

Ribbon Pinecones

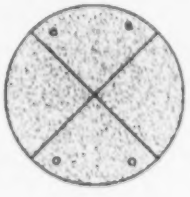
- Cut 3 yards of ribbon into 1-1/2 inch ribbon strips.
- Fold each into a triangular shape (do this as you go along).



- Starting from the bottom of the egg (the smaller end), pin 2 triangle points together onto the egg.



- Overlap the next 2 triangles so they cover the edges of the first 2 triangles.



- Moving down the egg in rows, add triangles so they are opposite each other and overlap the last row pinned. Try to keep the points in an even circle.

- Continue to add until the triangles meet at the top.

- Cut 4 pieces of felt. Each piece should be 1" x 3".

- Cut points at the corners.
- Pin felt pieces down (1 or 2 pins will hold all 4 pieces).

- Cut a 6-inch piece of thin ribbon for the handle.
- Secure the ribbon to the felt with 2 pins.

BEST COPY AVAILABLE

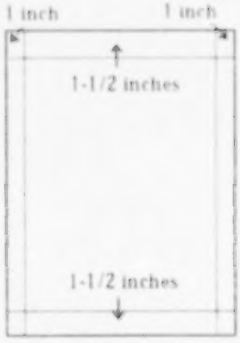
Crafty Mathematician

Handout 7-1

Gift Boxes

- Cut a greeting card along the fold.

- Place the picture side of the card face down with the longer sides to the left and right. Using a ruler and pen, draw a line 1-1/2 inches from the top. Draw another line 1-1/2 inches from the bottom.



- Leaving the card in the same position, use the ruler and pen to draw a line 1 inch from the left side of the card. Draw another line 1 inch from the right side.

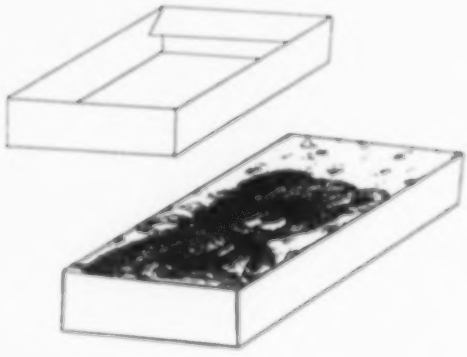
- *Cut along each of the 2 lines that start at the top of the card,* but cut only to where the lines intersect. *Do the same for the 2 lines that start at the bottom.* Again, cut only to where the lines intersect.

- Fold the card along the remaining uncut lines. Use the edge of a ruler to make a nice, sharp fold. Once all folds have been made, fold the 2 small tabs at the top so they will be inside the box. Do the same for the 2 tabs at the bottom.

- The 2 long tabs that remain stand up higher than the rest of the box. Fold these down over the 2 small tabs you folded in earlier. Tape these 2 pieces in place. The top of your box is now complete.

- To make the top of the box, you will repeat this process. This time, however, each of the previous 1-1/2-inch lines should be 1-9/16 inches; each of the previous 1-inch lines should be 1-1/16 inches. Draw your lines on the side of the card that has writing on it. This way, the message can be read when the box is opened.

- Place the top of the box over the bottom, and admire your small gift box.



BEST COPY AVAILABLE